BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[625. 143.4 (.54)]

Fish-plates on the Federated Malay States Railways,

By the ADMINISTRATION OF THESE RAILWAYS.

Figs. 1 to 34, pp. 1056 to 1072.

The object of this report is to embody the experience gained on the Federated Malay States Railways in the maintenance of flat-bottomed rail joints fished together with plates of varying lengths and sections and to endeavour to give cogent reasons for the change that is premeditated by the engineer for ways and works to fish-plates conforming to British Standard Specification.

The design of fish-plate at present in use on these Railways for the British Standard 80 lb. and 60 lb. rails and the Australian 80 lb. and 60 lb. rails, is a six hole angle plate. With the old section 60 lb. rails however, both six hole angle plates and four hole flat plates are used.

Figures 1 and 2 show the details of the six hole fish-plates used with the 80 lb. and 60 lb. British Standard rails.

Figures 3 and 4 show the details of the six hole fish-plates used with the 80 lb. and 60 lb. Australian rails.

Figures 5 and 6 show the details of the six hole and the four hole fish-plates used with the old section 60 lb. rails. Experience shows that the road fitted with the latter is in a more satisfactory condition than that fitted with the former. To increase the efficiency of the track it is therefore proposed to use only four bolt fish-plates in future.

Figures 7 to 10 show the fishplates proposed for renewals and future construction respectively. These would, of course, only be used when the existing stock of angle fish-plates had become exhausted. The distinction between renewals and future construction is due to the fact that the pitch and size of the present bolt holes do not agree with British Standard design.

Not only would these new proposals afford a substantial saving in the initial costs of the plates themselves, but from the results of practical experience on these railways with joints fished together with short plates, it is certain that maintenance charges for joint upkeep would be considerably reduced.

Table 2 gives the estimated saving, in

TABLE 1.

Suggested sleeper spacings for British Standard Specification four bolt fish-plates.

Sleeper spacings for 80 lb. and 60 lb. rails 30 feet long.			
At present : 12 sleepers per rail length.	Proposed :		
	Good track : 12 sleepers per rail length.	Bad track : 13 sleepers per rail length.	Very bad track : 14 sleepers per rail length.
Joint.	Joint.	Joint.	Joint.
11 1/2 inches.	10 1/2 inches.	10 1/2 inches.	10 1/2 inches.
2 ft. 5 in.	2 ft. 5 in.	2 ft. 2 in.	1 ft. 11 in.
...	2 ft. 6 in.	2 ft. 3 1/2 in.	2 ft. 1 in.
9 at 2 ft. 7 in.	7 at 2 ft. 7 in.	8 at 2 ft. 5 in.	9 at 2 ft. 3 in.
2 ft. 5 in.	2 ft. 6 in.	2 ft. 3 1/2 in.	2 ft. 1 in.
...	2 ft. 5 in.	2 ft. 2 in.	1 ft. 11 in.
11 1/2 inches.	10 1/2 inches.	10 1/2 inches.	10 1/2 inches.
Joint.	Joint.	Joint.	Joint.

Sleeper spacings for 60 lb. rails 24 feet long.			
At present : 10 sleepers per rail length.	Proposed :		
	Good track : 10 sleepers per rail length.	Bad track : 11 sleepers per rail length.	Very bad track : 12 sleepers per rail length.
Joint.	Joint.	Joint.	Joint.
11 1/2 inches.	10 1/2 inches.	10 1/2 inches.	10 1/2 inches.
2 ft. 0 in.	2 ft. 3 in.	2 ft. 2 in.	1 ft. 10 in.
...	2 ft. 5 in.	2 ft. 2 1/2 in.	2 ft. 0 in.
7 at 2 ft. 7 in.	5 at 2 ft. 7 in.	6 at 2 ft. 3 in.	7 at 2 ft. 1 in.
2 ft. 0 in.	2 ft. 5 in.	2 ft. 2 1/2 in.	2 ft. 0 in.
...	2 ft. 3 in.	2 ft. 2 in.	1 ft. 10 in.
11 1/2 inches.	10 1/2 inches.	10 1/2 inches.	10 1/2 inches.
Joint.	Joint.	Joint.	Joint.

initial costs, effected by substituting four bolt flat B. S. S. fish-plates for six bolt angle fish-plates on the 80 lb. road.

TABLE 2.

Estimated saving in cost of material by substituting four bolt flat B. S. S. fish-plates for six bolt angle plates.

Six bolt angle plates 80 lb. rails.

Weight per pair : 66 1/2 lb.

Cost per pair @ 8 cents per lb.	= $5.32
Cost of six bolts @ 39 cents each	= 2.34
Cost of four spikes @ 12 cents each . . .	= 0.48
Total cost per joint.	= $8.14

Four bolt B. S. S. flat fish-plates 80 lb. rails.

Weight per pair : 28 3/4 lb.

Cost per pair @ 8 cents per lb.	= $2.30
Cost of four bolts @ 39 cents each . . .	= 1.56
Total cost per joint . . .	= $3.86
Net saving per joint. . .	= $4 28

Say life of a fish-plate is twenty years and open lines have 1 000 miles of track.

Then number of pairs of fish-plates, etc., to be replaced per year :

$$\frac{350\ 000}{20} = 17\ 500 \text{ pairs.}$$

Net saving per year :

17 500 × $4.28 = $75 000 or $75 per mile.

Estimated saving for new work :

$4.28 × 352 per mile = $1 500 per mile.

As there is a difference in the lateral straining forces brought to bear on fish-plates fixed on the straight and on the curve, it will perhaps be convenient to investigate both cases separately, it being by no means certain that a fish-plate found to be suitable for straights might not fail, through insufficiency of lateral strength on curves.

A. — **Joints on straights or tangents.**

1. — It is found that long six bolt angle plates have a tendency to bind with the rails, so much so, that even when the fish-bolts have been entirely removed, it becomes almost impossible to remove the fish-plates unless they are sprung out of position by knocking the rails with a sledge hammer. This renders cleaning and oiling a difficult operation, it having been found that one cooly can remove and replace only ten pairs of plates per working day.

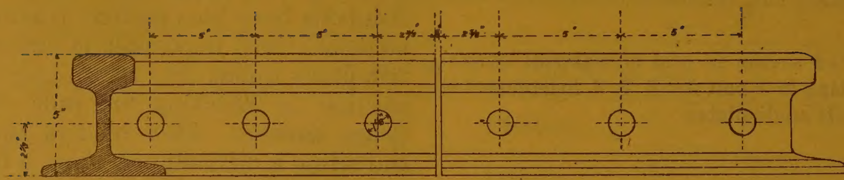
Slight buckling of the line occasionally occurs where binding is in evidence, and it is found to be generally due to tight fish-bolts which cause the fish-plates to grip the rails so tightly that they cannot move in them. Corrosion between rails and fish-plates soon occurs and expansion at such a joint becomes impossible.

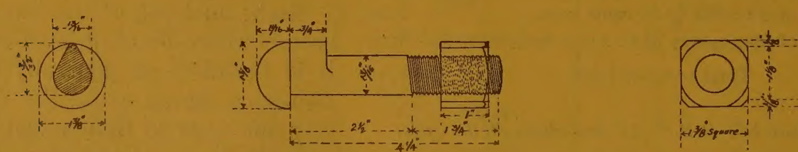
This tendency hardly exists on sections where four bolt flat fish-plates have been used with 60 lb. O. S. rails, and no difficulty has been experienced in removing these plates once all the fish bolts have been removed, thus showing that expansion and contraction is taking place properly.

2. — It is found that coolies cannot be depended upon to tighten up fish-bolts properly. They either screw them up far too tight and help to cause binding and its attendant evils, or else they screw them up too lightly.

An analysis of over one hundred joints taken haphazard on various districts revealed the fact that only one was screwed up in an efficient manner, and that about 80 % of the fish-bolts required slackening; therefore, it is evident that four hole fish-plates would prove less difficult to maintain then six hole fish-plates, owing to the fact that the former have

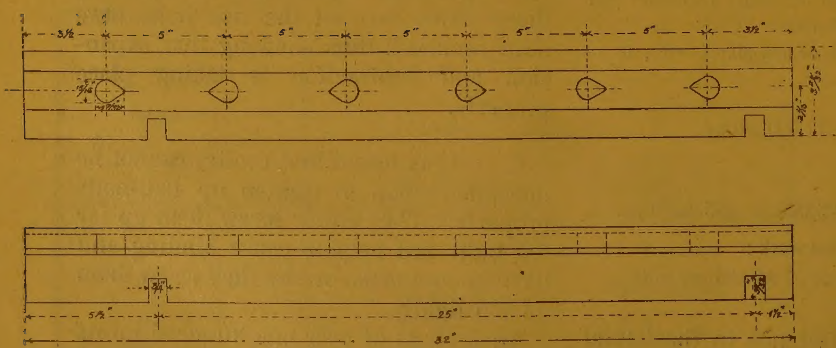
Details of bolt-holes in rails.





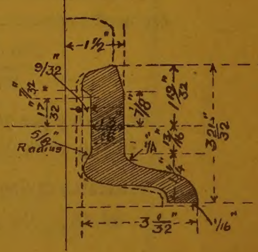
Details of fish-bolts and nuts.

Elevation.



Plan.

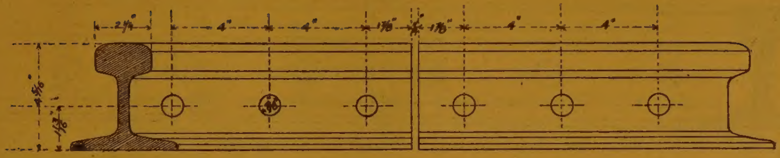
Details of fish-plates.

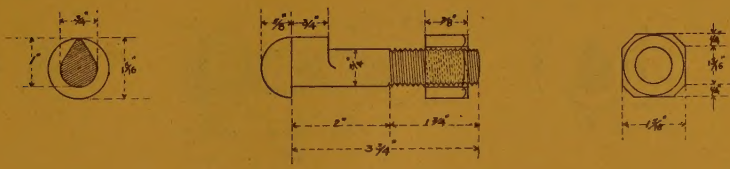


Section of fish-plate.

Fig. 1. — Details of fish-plates and fish-bolts in use, for 80 lb. B. S. S. rails.

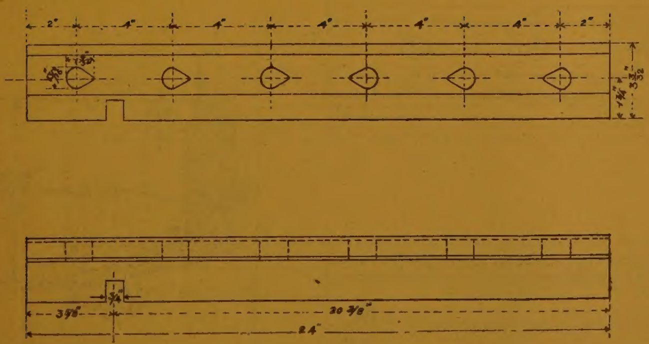
Details of bolt-holes in rails.





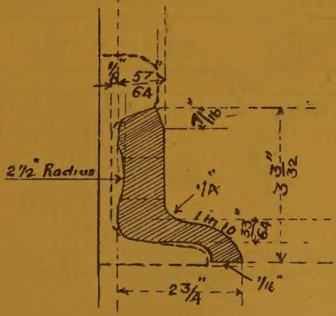
Details of fish-bolts and nuts.

Elevation.



Plan.

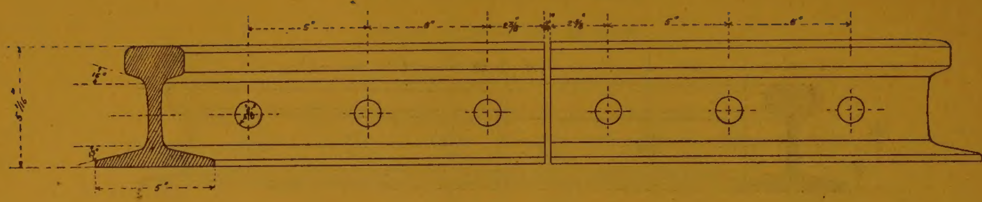
Details of fish-plates.

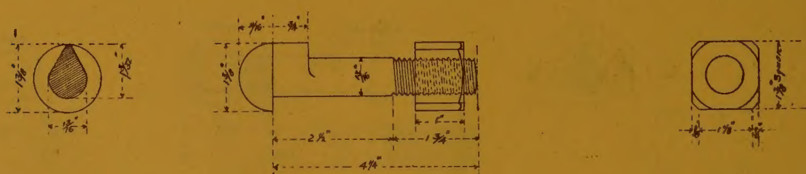


Section of fish-plate.

Fig. 2. — Details of fish-plates and fish-bolts in use, for 60 lb. B. S. S. rails.

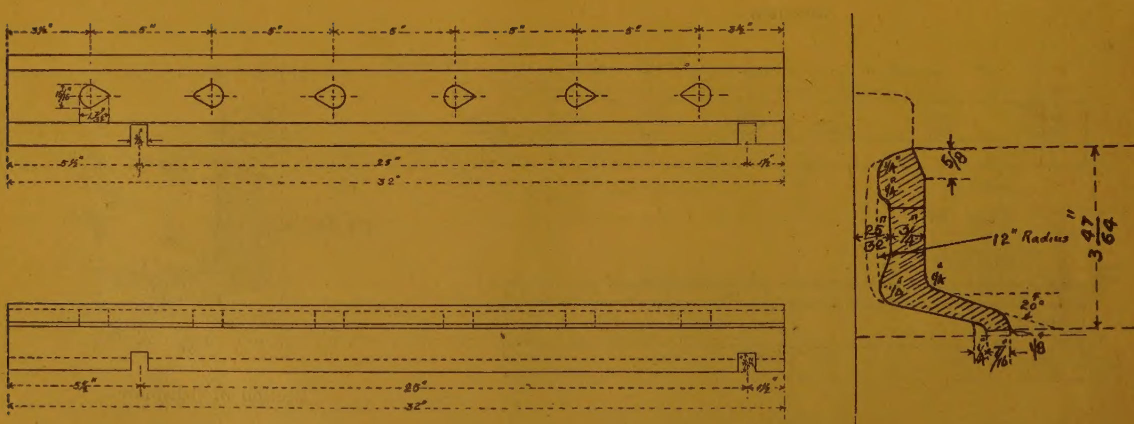
Details of bolt-holes in rails.





Details of fishing-bolts and nuts.

Elevation.



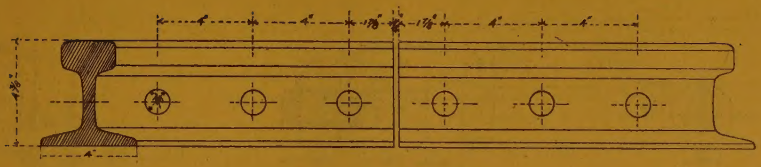
P an.

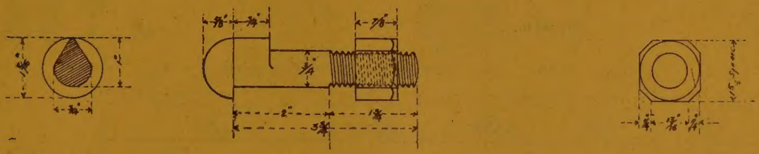
Section of fish-plate.

Details of fish-plates.

Fig. 3. — Details of fish-plates and fish-bolts in use, for 80 lb. A. S. rails.

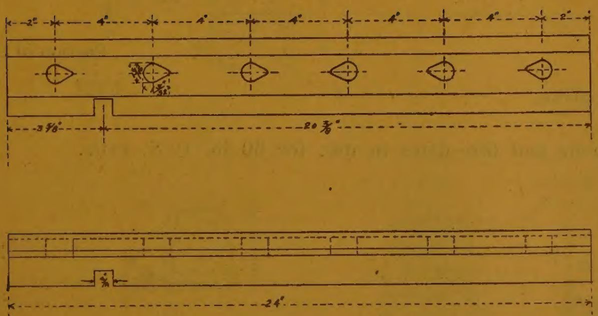
Details of bolt-holes in rails.





Details of fishing-bolts and nuts.

Elevation.



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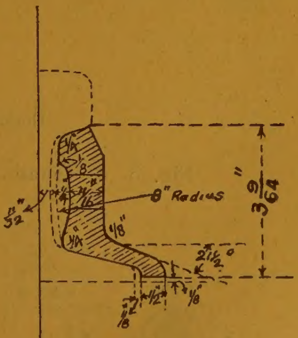
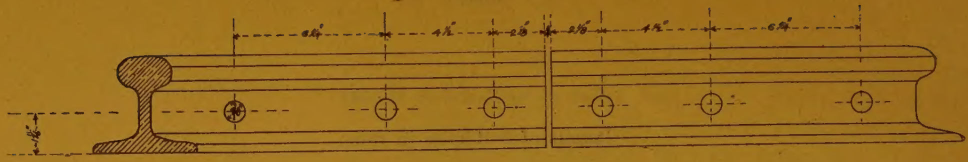


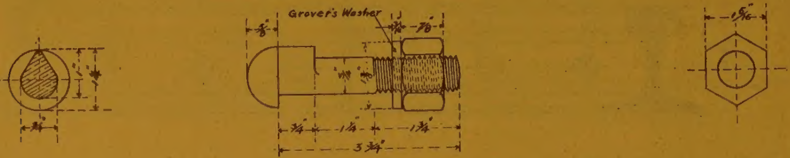
Section of fish-plate.

Details of fish-plates.

Fig. 4. — Details of fish-plates and fish-bolts in use, for 60 lb. A. S. rails.

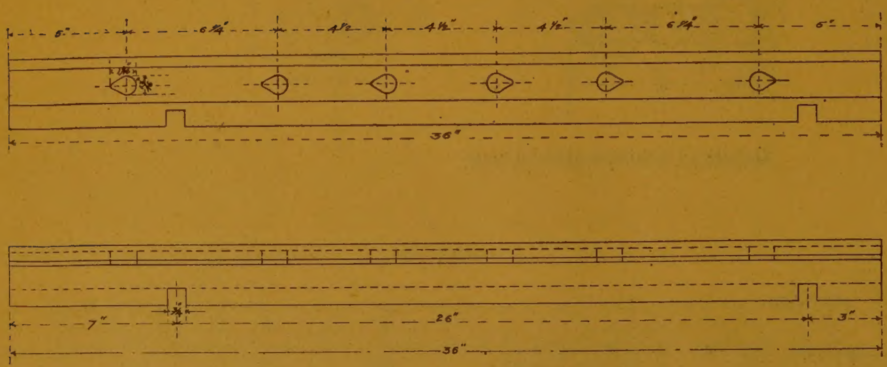
Details of bolt-holes in rails.



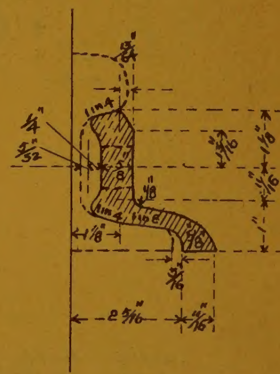


Details of fishing-bolt and nut.

Elevation.



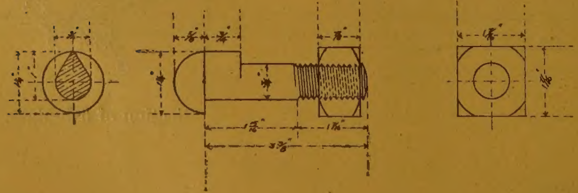
Plan.

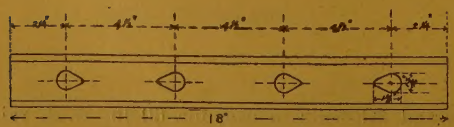


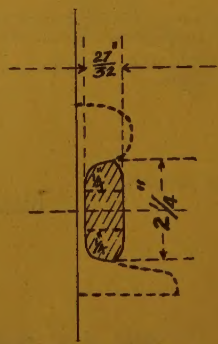
Section of fish-plate.

Details of fish-plates.

Fig. 5. — Details of fish-bolts and fish-plates in use, for 60 lb. O. S. rails.







Section of fish-plate.

Elevation.

Fig. 6. — Details of four-bolt-hole fish-plates and fish-bolts, for 60 lb. O. S. rails.

less fish-bolts to tighten up than the latter.

It is considered that the design of a fish-plate to suit labour conditions is a point of paramount importance on these railways.

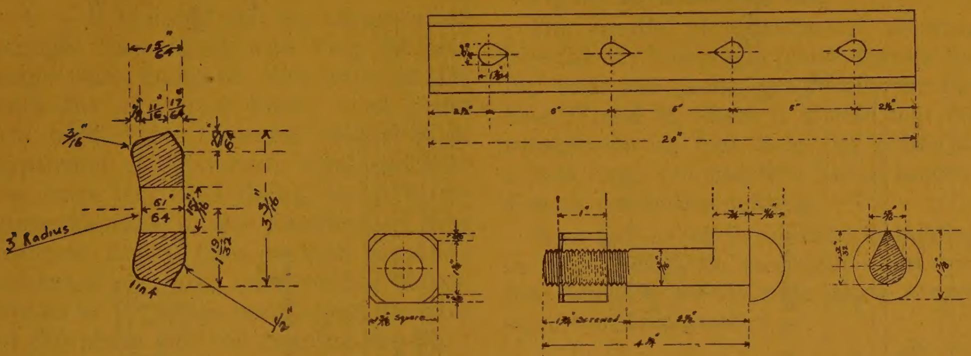


Fig. 7. — 80 lb. B. S. S. rails.

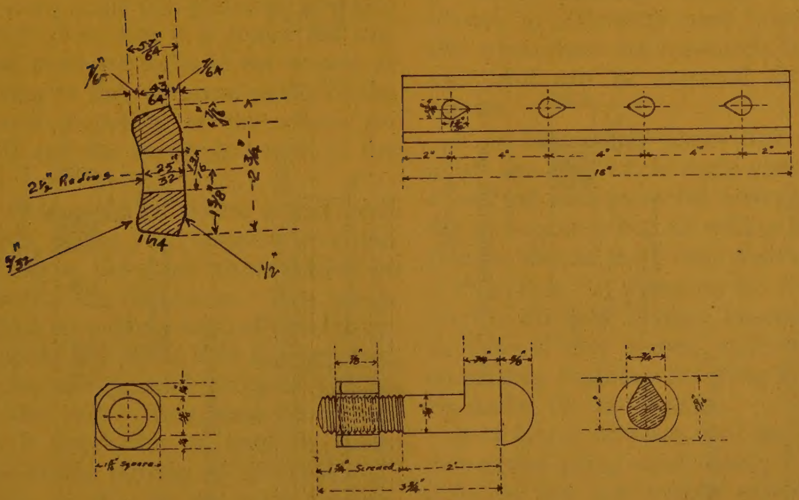
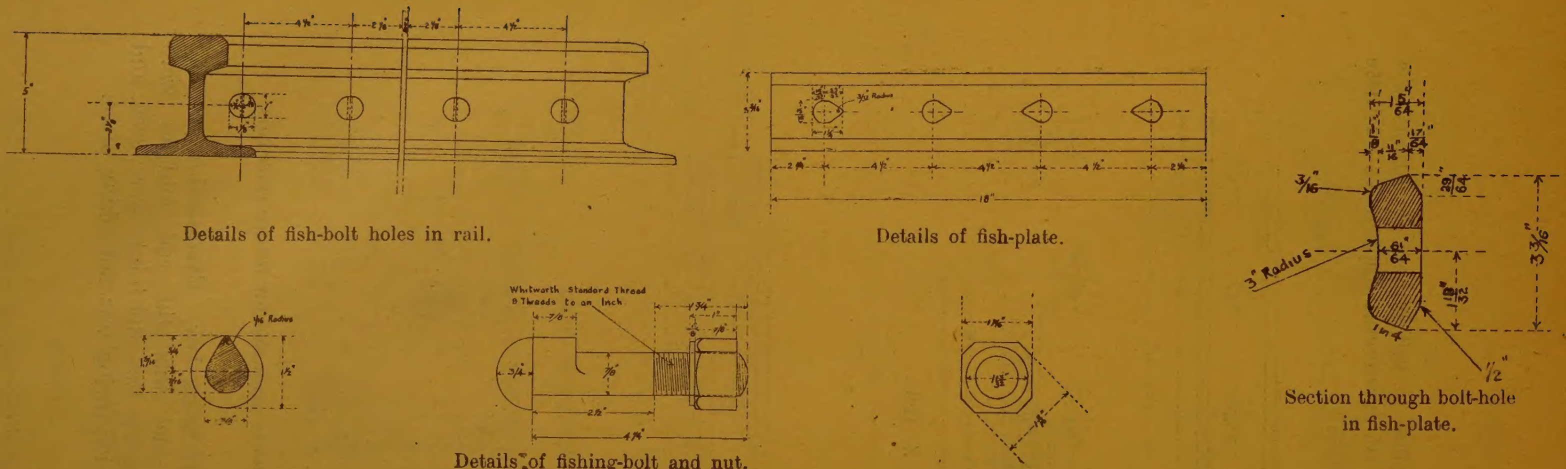


Fig. 8. — 60 lb. B. S. S. rails.

Figs. 7 and 8. — Details of fish-plates and fish-bolts proposed for future renewals.

3. — There have been cases where the 80 lb. road has buckled vertically, that is the rails have assumed a convex upward shape giving the appearance of all the joints being low. Examination revealed the fact that the rail middles were swinging, that the joints were level, and that expansion was not taking place.

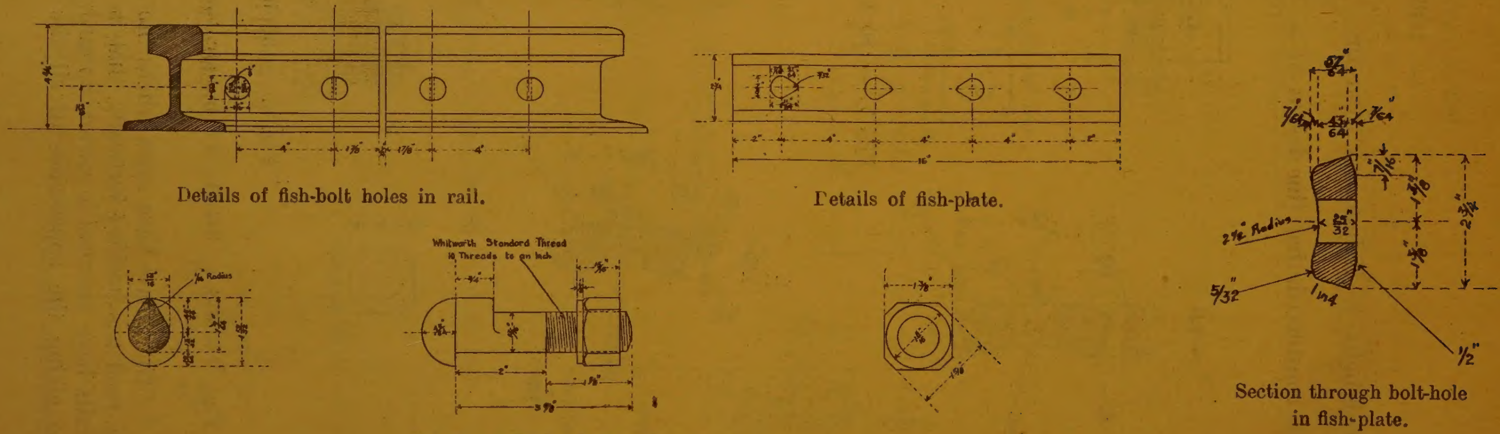


Details of fish-bolt holes in rail.

Details of fish-plate.

Details of fishing-bolt and nut.

Fig. 9. — 80 lb. B. S. S. rails.



Details of fish-bolt holes in rail.

Details of fish-plate.

Details of fishing-bolt and nut.

Fig. 10. — 60 lb. B. S. S. rails.

Figs. 9 and 10. — Details of fish-plates and fish-bolts proposed for new rails.

There are no known cases of vertical buckling of the line having occurred on these railways where flat fish-plates are in use.

4. — It is found that the alignment on straight lines fitted with long six hole angle plates compares very unfavourably with the alignment where short plates are used. The increased resistance to expansion of the former, combined with the extra length of fixing, seems to reduce the rails to the condition of long columns firmly fixed at both ends and subjected to large compressive forces. Points of inflection occur, near the ends of the plates and bad running results.

Figures 12 to 15 and 23 illustrate this point.

5. — Long angle fish-plates are stronger than short ones, but it is found that the strongest bend vertically in the course of time owing to the combined effect of the continuous pounding of the wheels on the joint and the excessive length of the plate.

This is emphasized where a soft road bed exists, as the joint sleepers sink and leave a sag at the joint which has to be supported by the fish-plates. This causes the fish-plates to bend vertically and when this happens the plates hold the deflected ends down and prevent efficient surfacing of the rails. This state of affairs renders it impossible to level the joint with the centre portion of the rails.

5 miles of the 60 lb. road between Taiping and Kamunting got into this condition and was only put right by changing the angle plates for short flat ones.

6. — Most of the low joints on the 60 lb. road between Tebong and Tampin on the Seremban District were found to be due to bent angle fish-plates. These were of the six hole variety, 36 inches long, and some of them were bent vertically as much as 1/4 of an inch.

Figure 22 illustrates this.

The results of experiments shewing how the six hole angle plates depress the rail ends are shewn graphically in figures 27 and 28 where it is seen that the substitution of four hole flat plates 20 inches long, reduced this initial depression to practically nothing.

Bent fish-plates in addition to holding the rail ends down materially assist vertical buckling of the rails where proper expansion is prevented.

7. — Many of the low joints that were examined were found to be primarily due to faulty packing. Coolies cannot be trusted to efficiently pack joint sleepers and when these are insecurely bedded no rail joint can be expected to do good service.

It is found that where this condition exists the long 6 hole angle plates become converted into powerful leverages under the impulsive action of rolling loads, and thus accelerate their own destruction.

Four hole flat plates on the other hand can be reversed if they become slightly bent, or if they become worn at the rail ends, thus enabling the plate to fit close up under the rail again.

It is found, however, that the four hole fish-plates being short rarely bent vertically to any appreciable extent, practically the whole of this distortion being confined to the longer plates.

A particularly bad low joint on the straight was investigated on the Seremban District at 291 1/2 mile. The joint was 3/8 inch low and when the six hole plates were taken off it was found that they were badly worn, as is shown in

figures 33 and 34 and that they were not bent.

In this particular case packing strips could have been inserted to prevent play, although if similar wear had occurred with a pair of flat plates, it would have been possible to have remedied the evil by simply reversing the plates.

8. — Experience on most districts is that when long plates are taken off for any purpose and replaced it is very difficult to get the bolts back again.

9. — It is found that long six hole plates cause jumping at the non-loaded rail ends and that practically no jumping occurs with short four hole plates.

In other words, the tendency of a short fish-plate is to depress the non-loaded rail ends exactly the same amount as the loaded end. This enables rolling stock to pass over the joint without excessive knocking.

Figures 29 and 30 illustrate this point.

10. — It is found that severe hammering due to want of elasticity takes place with the six hole angle plate joint where a firm road bed exists. This causes burring over of the rail ends and consequent failure of the joint. An example of this is shown in figure 11. Too great a rigidity also entails increased wear on the rails and rolling stock.

Parts of the 60 lb. road fitted with four hole flat plates that were examined did not exhibit this fault.

11. — Long angle fish-plates have the following advantages over short flat plates :

a) The pressure on the sleepers is divided more equally and sinking of the sleepers is better prevented;

b) The tendency of the rails to creep is counteracted to a certain extent;

c) The horizontal flanges give lateral stability to the joints and carry part of the load directly to the sleepers, thus relieving the rail ends to that extent.

It is found that these advantages are of no practical importance on these railways for the following reasons :

a) A comparatively heavy section of rail is at present in use;

b) Creep has not been stopped to any appreciable extent since they have been fitted;

c) The necessity for increased lateral stability on the straight line has not been demonstrated under actual running conditions.

12. — Table 1 gives the sleeper spacings suggested for use on track fitted with four bolt flat fish-plates where the road bed varies from firm to soft.

It will be noticed that a diminution in joint sleeper spacing is embodied. This, it is thought, will result in increased efficiency at the joints.

13. — In general, it is found that lengths of straight line where short flat plates have been fitted are in a far better condition and give far less trouble than similar lengths where long angle plates are used.

B — Joints on curves.

1. — Joints on curves are subjected to far greater lateral forces than joints on straights, these lateral forces increasing with the curvature.

From considerations of this fact it is evident that angle plates should help to keep better alignment on sharp curves than flat plates of equal length, although

on easy curves, say over 3 000 feet radius, similar remarks to those given for joints on straights apply.

2. — Where the line is curved, distortions caused either directly or indirectly by a bad design of joint fastening appear

80 lb. B. S. S. rail, 32 inch 6-bolt angle plate, square joints; joint sleeper spacing : 2 ft. 1 in. — Weight of plates : 66 1/2 lb. per pair; straight road, gravel ballast, consolidated bed.

Note the following points :

1° burring over of rail ends due to excessive rigidity;
2° considerable wear on rails entailed through want of elasticity.

Fig. 11. — Rail joint near Kuala Lumpur station.

as crooked alignment; and it is found on these railways that the alignment on most curves is unsatisfactory and requires constant attention. Experience shows that better running is obtained on curves of over 3 000 feet radius, with square joints than with staggered or broken joints, while on curves of under 3 000 feet radius exactly opposite remarks apply.

3. — It is considered that the rails in all sharp curves should be permanently set by Jim Crow before being laid in the road, as this precaution would ensure the destruction of the inherent resilience or elastic potential of the rail, resilience being taken to mean the power of the rail to spring back on the removal of the straining forces.

The necessity for bending rails permanently before laying them in a curved track increases with the weight of the rails and with the sharpness of the curvature, and decreases as the rail length increases and as the rail is held securely to its place under traffic. An initial set is also of far more importance with F. B. rails than with D. H. rails as the bottom flange of the former complicates true bending.

4. — Curves on these Railways are

T. P. 1/18-1/19 Kuang-Batang Berjuntai branch. 60 lb. B. S. S. rails, 24 inch 6-bolt angle plates. Damp clay formation, irregular expansion.

Fig. 12. — *Bad alignment and joints 3/32-1/4 inch low.*

T. P 460/2 main line between Senai and Tampoi. 80 lb. rails, 32 inch 6-bolt angle plates, square joints, soft clay formation.

Fig. 13. — *Line slewed 7 days before photograph taken.*

Fig. 14. — T. P. 226/16 main line, near Kuang; 80 lb. rails, 32 inch 6-bolt angle plates, staggered joints, gravel ballast, low joints and bad alignment restricted expansion.

Fig. 15. — T. P. 4 9/8 main line, 80 lb. rails, 6-bolt angle plates 32 inches long, square joints, restricted expansion.

Fig. 16. — T. P. 240/2 main line near Batu junction; 80 lb. rails, 32 inch angle plates, 4° curve, square joints, crooked alignment, fish-plates bent laterally 1/18-3/32 inch.

Fig. 17. — T. P. 240/1 main line; another view of curve shown in figure 16, approaching Batu junction. Note series of elbows and straights.

Fig. 18. — T. P. 240/7 main line, approaching Maxwell Road, 4° curve, 80 lb. rails square joints, 32 inch 6-bolt angle plates, curve rides badly.

Fig. 19. — T. P. 1/9 Kuang-Betang Berjuntai branch, 60 lb. B. S. S. rails, 24 inch 6-bolt angle plates, 1 1/2° curve, square joints, soft formation

Fig. 20. — T. P. 325/20 main line between Tebong and Tampin, 60 lb. O. S. rails, 36 inch 6 bolt angle plates. Note kink in left hand rail at joint due to joint sleepers not being properly adzed, square joints.

Fig. 21. — 323 mile main line, 60 lb. O. S. rails, 36 inch angle plates, square joints, wet cutting, joints very low, bolts on all joints screwed up too tightly.

Fig. 22. — T. P. 325/4 main line, 60 lb. O. S. rails, 36 inch 6-bolt angle plates, fairly hard formation, square joints, joint 3/8 inch low due to plate being bent vertically 1/4 inch, joint sleepers beaten up but no improvement.

Fig. 23. — T. P. 461/8-9 main line between Senai and Tampoi, wet clay cutting, 80 lb. rails, square joints, 5 rail lengths fitted with 4-bolt angle plates 20 inches long made by cutting down 32 inch plates. Note improvement in alignment as compared with line near trolley where 32 inch plates are fitted.

Fig. 24. — T. P. 460/13 main line, 80 lb. rails, square joints, 32 inch angle plates, inner rail bent outwards 1/4 inch due to tightness of gauge.

Fig. 25. — T. P. 225/17 maine line between Kuang and Rawang, 4° curve staggered joints, 80 lb. rails, 32 inch angle plates, sand and stone ballast, expansion moderate. Note improvement due to staggering.

Fig. 26. — T. P. 0/12 Batu Caves branch, 80 lb. B. S. S. rails, 32 inch 6-bolt angle plates, bad alignment, and low joints, bad expansion and corroded fish-plates.

usually laid without previous setting being sprung to curve by slewbars, and then held by the spikes.

Although this practice appears to be justified on curves of moderate sharpness, it is found to cause unsatisfactory

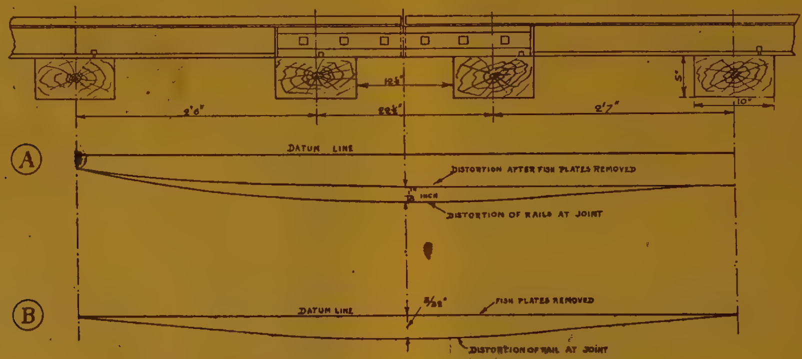


Fig. 27. — Distortion at joints (6-bolt angle plates).

Curves of deflection, plotted to a distorted scale, showing how long 6-bolt angle fish-plates tend to distort joints.

Curves (A) taken at telegraph post 188/20 F. M. S. R. at a low joint that was indifferently packed.

Curves (B) taken at telegraph post 242/27 F. M. S. R. at a joint that was moderately well packed.

Details : weight of rail = 80 lb. per yard; weight of angle plates = 66 1/2 lb. per pair; length of plates = 32 inches; other dimensions as shown.

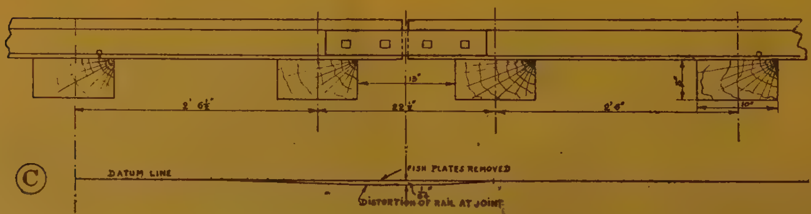


Fig. 28. — Distortion at joints (4-bolt flat fish-plates).

Curves of deflection plotted to same scale as (A) and (B) showing how a 4-bolt flat fish-plate reduces the distortion.

Curves (C) taken at telegraph post 242/27 F. M. S. R. at next joint to that from which curves (B) were obtained, joint was moderately well packed.

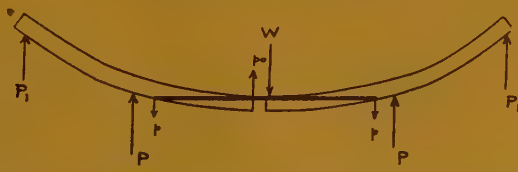
Details : weight of rail = 80 lb. per yard; weight of fish-plates = 32 lb. per pair; other dimensions as shown; length of fish-plates = 20 inches.

alignment on curves of 3° and over (under 2 000 feet radius), owing to the gradual loosening of the dog-spikes caused by the passage of rolling stock.

Once these spikes work loose it is evident that undue stresses are developed at the fish-plates due to the resilience or elastic potential of the rail asserting itself.

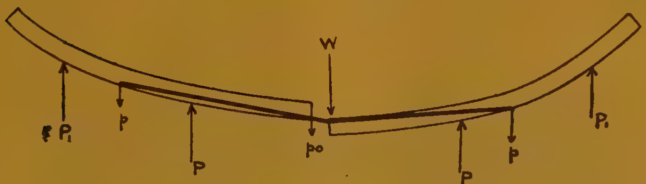
It is often found that these stresses are sufficient to permanently bend or distort the fish-plates, and theory discloses the fact that the stresses set up in a 32 inch angle plate due to the resilience of an 80 lb. F. B. rail curved to 3° may reach 14 tons per square inch, which stress approximates to the elastic limit of the steel.

Short four-bolt fish-plates.



Both rail heads are pressed downwards so that the passing over of W takes place without knocking.

Long six-bolt fish-plates.



Jumping of rail end and a jerk or jar at passing over of W.

Figs. 29 and 30. — Diagrammatic conception of the effect of long and short fish-plates.

Notes. — 1° Rails are represented by two parallel lines the distance apart of which represent the play;

2° Fish-plates are represented by one single thick line which must pass continuously between the parallel lines;

3° Reaction of sleepers = P and P_1 of which P is the greater;

4° Reaction of fish-plates = p and p_0;

5° Weight on driving wheel = W.

Lateral buckling of the fish-plates took place on the 80 lb. road, between Kuala Lumpur and Batu Junction where the long angle plates on the curves became permanently distorted, giving the line the appearance of a series of elbows and straights.

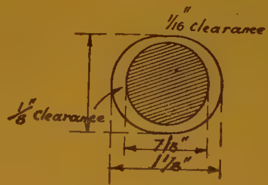
Figures 16 to 19 illustrate this.

It was found that similar faults existed on the Seremban District between Tebong and Tampin, some of the 36 inch angle plates fitted to curved 60 lb. O. S. track being bent laterally as much as 3/16 of an inch.

4-bolt fish-plate.

Length of plate. . . . . 18 inches.
Spacing between centres of holes . . . $4\,^1/_2$ —

Section of fish-bolt and bolt-hole in rail.



Section of fish-bolt neck and bolt-hole in fish-plate.

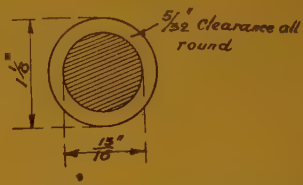
Weight per pair . . . . $28\,^3/_4$ lb.

Fig. 31.

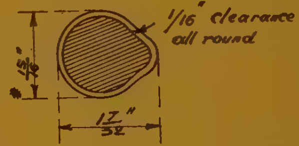
6-bolt fish-plate.

Length of plate. . . . . 32 inches.
Spacing between centres of holes . . . 5 —

Section of fish-bolt and bolt-hole in rail.



Section of fish-bolt neck and bolt-hole in fish-plate.



Weight per pair . . . . $66\,^1/_2$ lb.

Fig. 32.

Figs. 31 and 32. — Comparison between 4-bolt fish-plate B. S. S. and 6-bolt angle fish-plate in use with 80 lb. rails.

Fig. 33. — Sketch showing wear at centre of fish-plate. 6-bolt pattern.

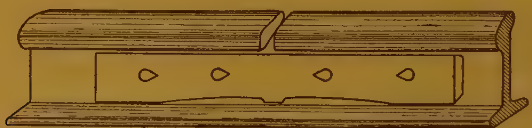


Fig. 34. — Sketch showing how similar wear on a 4-bolt flat plate could be rectified by reversing the plate.

It is impossible to remedy this defect by slewing although this has been unsuccessfully tried in many instances.

It is considered that the cheapest efficient method of tackling the problem would be to take the bent plates off, turn them end for end and replace them, at the same time easing the straining forces on the fish-plates by means of permanently setting the rails by nipping their ends with a jim crow. This has since been tried on some of the curves between

Kuala Lumpur and Batu Junction and the alignment was much improved by the treatment.

5. — To maintain good alignment on curves of 3° and over, on open lines on these Railways, it would appear that the ends of all rails should be nipped two or three times with a jim crow to enable resilience to assert its effect only when extraneous straining forces come into play.

If this were done there is no doubt that *short four hole angle plates* would tend to preserve the alignment better than flat fish-plates of equivalent length. In practice, however, it is doubtful whether the increased lateral strength of these heavier plates would be justified, it being considered that a more efficient economy would be obtained by employing four hole flat plates and by staggering the joints on all curves of under 3 000 feet radius, it having been found that rails with square joints have only about 70 % of the lateral strength of those with staggered joints.

Figure 25 illustrates the benefits obtained by staggering joints with an 80 lb. road on a 4° curve.

6. — On sharp curves the length of the six hole plate is against good alignment, and it is found that it is difficult, if not impossible, to properly slew the curves fitted with these long plates, the tendency of the plates being to force the rails back to the position they occupied before slewing was attempted.

Summing up, maintenance experience has shewn that most of the trouble with rail joints on these railways can be traced either directly or indirectly to the use of the long six hole angle plates which have exhibited the following faults in operation :

1° Binding of plates to rails causing lateral buckling;

2° Difficulty of preserving alignment on straights and on curves;

3° Vertical distortion of plates, causing depression of rail ends, and vertical buckling;

4° Lateral distortion of plates on sharp curves;

5° Difficulty of taking off plates for cleaning and oiling;

6° Difficulty in replacing plates when once taken off;

7° Difficulty in housing plates snugly up against the rails;

8° Jumping at non-loaded rail end;

9° Extreme rigidity, causing burring over of rail ends.

Four hole flat plates on the other hand, would prove beneficial for the following reasons :

1° The tendency to bind and distort would be considerably reduced;

2° Better alignment could be kept;

3° The plates could be easily taken off, cleaned, oiled and replaced;

4° The plates would be reversible, *i. e.* they could be turned when bent or worn;

5° There would be a considerable economy in first cost, and in maintenance cost;

6° There would be no jumping or burring over of the rail ends;

7° The plates could be snugly housed to the rails.

Therefore, in conclusion it is certain that the substitution of the four bolt flat plates of B. S. S. pattern, and the staggering of joints on curves of under 3 000 feet radius, would in addition to effecting a large saving in maintenance greatly increase the efficiency of the track.

[624. (01 (.73)]

Proposed new American rules for the design of metal bridges.

Figs. 1 to 3, pp. 1074 and 1075.

(*Proceedings of the American Society of Civil Engineers*, January 1923.)

We give below an extract of the *Proceedings of the American Society of Civil Engineers*, giving the more important details of the new rules for the design and construction of steel railway bridges put forward by the American Society of Civil Engineers.

4. — *Type of bridge.* — The type of bridge to be used for various span lenghts may be as follows :

Rolled beams up to	30 feet.
Plate girders from.	30 to 125 feet.
Riveted trusses from . . .	100 feet and over.
Pin-connected trusses from.	150 feet and over.

5. — *Spacing of girders and trusses.* — The girders of deck bridges and stringers, where two are used on each track to carry open floors, shall not be spaced closer than 6 ft. 6 in., center to center.

The width between centers of trusses or girders shall be sufficient to give lateral stiffness and to prevent overturning by the specified lateral forces, and, in no case, shall be less than one-twentieth of the span.

6. — *Depth ratios.* — The depth of trusses preferably shall be not less than one-tenth of the span. The depth of plate girders preferably shall be not less than one-twelfth of the span. The depth of rolled beams used as girders and the depth of solid floors preferably shall be not less than one-fifteenth of the span. If less depths are used, the section must be increased so that the maximum deflection will not be greater than if these limiting ratios had not been exceeded.

7. — *Clearance.* — The clearance on straight track shall not be less than that shown in figure 1. On curves, addi-

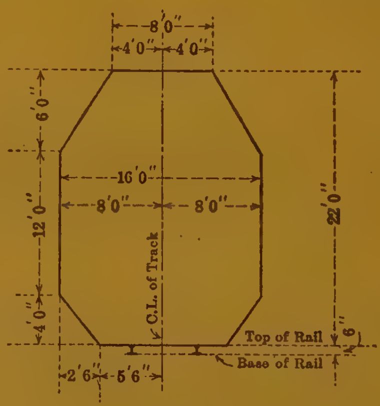


Fig. 1.

tional provision shall be made for a car, 80 feet long, 60 feet between truck centers, 14 feet high above the top of a 6-inch rail, and with allowance for super-elevation of the outer rail. Unless otherwise specified, the super-elevation of the outer rail shall be 3/4 inch for each degree of curvature, with a maximum of 6 inches.

101. — *Loads.* — Stresses shall be

shown separately for the following: Dead load, live load, impact, centrifugal force, and lateral and longitudinal forces. Members shall be proportioned for the combination giving maximum sections, except as otherwise provided.

103. — *Live loads.* — The live load for each track shall consist of typical engines followed by a uniform train load, according to either Class E series, or Class M series, as may be specified by the Engineer. It shall be a multiple of one or the other of the loads with wheel spacings, as shown in figures 2 and 3.

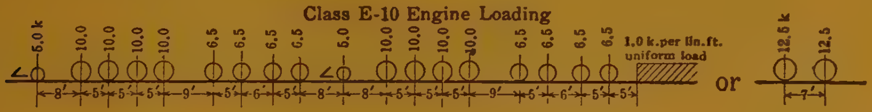


Fig. 2.

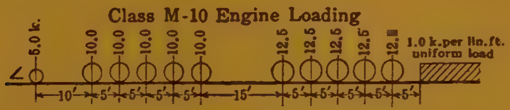


Fig. 3.

Loading E-60 or loading M-50 is recommended for main-line bridges of American railways.

104. — *Impact.* — The dynamic increment of the live load shall be added to the maximum computed live load stresses and shall be determined by the formula:

$$I = S\frac{300}{L + 300},$$

in which:

I = impact or dynamic increment to be added to live load stresses;

S = computed maximum live load stress;

L = loaded length of track, in feet, producing the maximum stress in the member. For bridges carrying more than one track, the aggregate length of all tracks producing the stresses shall be used.

Impact shall not be added to stresses produced by longitudinal and lateral or wind forces.

105. — For bridges designed exclusively for electric traction, impact shall be taken as one-third of that given by the impact formula.

107. — *Centrifugal force.* — Structures on curves shall be designed to resist the centrifugal force of the live load applied 7 feet above base of rail, as computed by the following formula:

$$C = \frac{0.067\,WV^2}{R},$$

in which,

C = horizontal centrifugal force;

W = live load, including impact;

R = radius of curve (5 730 ÷ degree of curve);

V = speed, in miles per hour = (60 — 21/2 times the degree of curve).

108. — *Lateral forces.* — All spans shall be designed for a lateral force on the loaded chord of 200 lb. per lineal foot plus 10 % of the specified train load on one track, and 200 lb. per lineal foot on

the unloaded chord, these forces being considered as moving.

109. — *Wind force.* — Viaduct towers shall be designed for the one of the following loads that causes the greater stress:

Viaduct towers shall be designed for a force of 50 lb. per square foot on one and one-half times the vertical projection of the structure unloaded; or 30 lb. per square foot on the same surface plus 400 lb. per lineal foot of structure applied 7 feet above the rail for the assumed wind force on the train when the structure is either fully loaded or loaded on either track with empty cars assumed to weigh 1 200 lb. per lineal foot, whichever gives the larger stress.

110.— *Longitudinal force.*— Provision shall be made for the starting and stopping of trains, with a coefficient of friction on the engine drivers at 20 % and on the balance of the train at 10 %.

111. — *Temperature.* — On simple spans, provision shall be made for expansion due to a variation in temperature of 120° Fahr.

112. — *Alternate stresses.* — Members subject to alternate stresses of tension and compression shall be proportioned for the kind of stress requiring the larger section. If the alternate stresses occur in succession during the passage of one train, as in stiff counters, each stress shall be increased by 50 % of the smaller. The connections of such members shall be proportioned in all cases for the sum of the stresses thus increased.

If the live load and dead load stresses are opposite in character, only two-thirds of the dead load stress shall be considered as effective in counteracting the live load stress. This reduction of dead load shall not be made in proportioning members subject to alternate stresses.

114. — For stresses produced by combination of longitudinal or lateral and wind forces with live load, dead load, impact, and centrifugal force, the unit stresses may be increased 25 % over those specified in article 201. When secondary stresses are included, the unit stress may be increased 33 1/3 %. In no case shall the section be less than that required for dead load, live load, impact, and centrifugal force at the unit stresses specified in article 201, or less than that required if secondary stresses are not considered.

115. — *Secondary stresses.* — Secondary stresses shall be avoided where possible in designing and detailing. In ordinary trusses without sub-paneling, secondary stresses due to distortion need not be considered in any member the width of which measured parallel with the plane of flexure is less than one-tenth of its length. All other secondary stresses shall be computed.

Unit stresses.

201. — The unit stresses to be used in proportioning the several parts of the structure shall be as follows:

Allowable stresses
for structural and rivet steel:

	Kips per [1] square inch.
Tension.	16.0
Compression (one diameter).	16.0

Compression on columns :

$$p = \frac{16.0}{1 + \dfrac{l^2}{13\,500\, r^2}}$$

in which:

p = allowable unit stress ;
l = length of member, in inches;
r = least radius of gyration of member, in inches;

[1] 1 k. = 1 000 lb.

but not to exceed	14.0
Bending in extreme fibers of rolled shapes, built sections, and girders, net section	16.0
Bending in extreme fibers of pins.	24.0
Shear in plate-girder and I-beam webs, net sections	12.0
Shear in pins and power-driven rivets	12.0
Shear in turned bolts and hand-driven rivets	10.0
Bearing on pins, power-driven rivets, outstanding legs of stiffener angles, and other steel parts in contact	24.0
Bearing on turned bolts and hand-driven rivets	20.0
Bearing on countersunk rivets. Only one-half the countersink shall be computed as bearing surface.	
Bearing on rollers per linear inch.	0.6 d

in which,

d = diameter of roller, in inches.

For cast-steel shoes and pedestals, the allowable unit stress for structural steel will apply.

For members composed of steel of greater strength than structural grade the allowable stresses may be increased in proportion to the higher yield point of the stronger steel, provided the yield point is not more than 70 % of the ultimate strength. In the column formula, the fractional portion of the denominator should be increased in the same ratio.

202. — *Limiting length of members.* — The lengths of main compression members shall not exceed 100 times their least radius of gyration, and those for wind and sway-bracing 120 times their least radius of gyration.

The lengths of riveted tension members shall not exceed 200 times their least radius of gyration.

204. — *Allowable pressure on masonry:*

	Kips per square inch.
Granite masonry	0.8
Limestone and sandstone (good quality)	0.4
Concrete (1-2-4).	0.6

307. — *Maximum length of rivet.* — The total thickness of plates connected by rivets shall not exceed six times the nominal diameter of the rivet to be used.

308. — *Pitch of rivets.* — Rivets shall be proportioned by their nominal diameter. They shall not be spaced, center to center, closer than three diameters nor farther apart, in the direction of the stress, than sixteen times the thickness of the thinnest plate connected, nor farther apart, at right angles to the line of stress, than thirty times that thickness, except in the cover-plates of compression members, where the spacing may be forty times the thickness of the thinnest plate. The pitch of rivets at ends of built compression members shall not be more than four diameters, for a distance of 1 1/4 times the width of the member.

312. — *Latticing compression members.* — All segments of members in compression, connected by latticing only, shall have batten-plates at each end. The thickness of such plates shall not be less than one-fortieth of the distance between the rivets connecting them to the compression member. In no case shall the length of such batten-plates be less than 1 1/4 times the width of the member. Where intermediate batten-plates are used, their length shall be at least three-quarters of the width of the member.

313. — The distance between the connections of latticing shall be such that the individual members between them, composing the column shall be relatively stronger than the column as a whole.

314 — *Single lattice-bars.* — Single lattice-bars shall generally be inclined at an angle of 60° with the axis of the member, and double lattice-bars at an angle of 45° riveted at the intersection. Single lattice-bars shall have a thickness of not less than one-fortieth, and double lattice-bars not less than one-sixtieth, of the distance between rivets connecting them to the compression member.

315. — The latticing of compression members shall be proportioned to resist shearing stress normal to the member not less than that calculated by the formula:

$$R = \frac{Pl}{4\,000\, y}.$$

in which:

R = normal shearing stress, in pounds;
P = strength of column as a compression member, expressed in pounds;
l = length of column, in inches;
y = distance from neutral axis to extreme fiber, in inches

In a compression member with a cover-plate, the cover-plate will be assumed to take one-half the shear.

316. — The diameter of the rivets shall not exceed one-third the width of the bar.

320. — *Lateral bracing.* — Through bridges shall be provided with post brackets at the intermediate panel points, of sufficient strength to maintain the panel in a vertical position under the specified wind pressure. When the height of the top chord is more than 26 feet above the floor, an overhead system of sway-bracing shall be used.

323. — *Plate girders.* — Plate girders shall be proportioned by assuming that the flanges are concentrated at their centers of gravity, but in no case beyond the back of the flange angles. One-eighth of the gross section of the web may be considered as flange area, provided the web is properly spliced to transmit its bending moment. For unusual sections, the net section modulus shall be used.

324. — *Compression flanges.* — The gross section of compression flanges of plate girders or I-beams shall not be less than the gross section of the tension flanges, but the stress per square inch shall not exceed:

$$16\,000 - 150\,\frac{l}{b}$$

in which:

l = length of unsupported flange, between lateral connections or knee-braces, in inches; and
b = width of flange in inches.

325. — When flange plates are used, at least one plate on each flange shall extend the full length of the girder, and on through bridges, an end and corner cover-plate shall be used. Any additional flange plates shall be of such length as to allow two rows of rivets of the regular pitch to be placed at each end of the plate, beyond the theoretical point required, and there shall be a sufficient number of rivets at the ends of each plate to transmit its stress value before the theoretical point of the next outside plate is reached.

329. — *Intermediate stiffeners.* — Webs shall be stiffened by angles riveted thereto in pairs, with outstanding legs not exceeding sixteen times their thickness and not less than 2 inches plus one-thirtieth of the depth of the girder. Intermediate stiffeners shall be placed at intervals not exceeding the depth of the web, or 6 feet.

330. — If the depth of the web between the flange angles or side-plates is less than fifty times the thickness of the web, intermediate stiffeners may be omitted.

331.— *Expansion rollers.*— All bridges 80 feet or more in length, that bear on masonry, shall be provided with pin-bearing bolsters, and, at one end, shall have turned rollers not less than 4 inches in diameter, placed between two planed surfaces. Spans of less than 80 feet shall be free to move at one end on planed surfaces without rollers.

SECTION 7. — **Structural steel for bridges.**

706. — *Tension tests:*

(*a*). — The material shall conform to the requirements as to tensile properties given in table 1.

(*b*). — In order to meet the required minimum tensile strength of full-size annealed eye-bars, the purchaser may determine the tensile strength to be obtained in specimen tests; the range shall not exceed 4 000 lb. per square inch, and the maximum shall not exceed 74 000 lb. per square inch. The material shall conform to the requirements as to physical properties other than that of tensile strength, specified in articles 706 (*b*), 707 (*b*), and 708 (*b*).

TABLE 1.

PROPERTIES CONSIDERED.	*Structural steel.*	*Rivet steel.*
Tensile strength, in pounds per square inch.	55 000-65 000 (1)	46 000-56 000
Yield point, minimum, per square inch	0.5 tensile strength	0.5 tensile strength.
Elongation in 8 inches, minimum percentage.	$\frac{1\,500\,000\ (2)}{\text{Tensile strength.}}$	$\frac{1\,500\,000}{\text{Tensile strength.}}$
Elongation in 2 inches, minimum percentage.	22	...

(1) See article 706, paragraph (*b*).
(2) See article 707 (not reproduced).

(*c*). — The yield point shall be determined by the drop of the beam of the testing machine.

SECTION 8. — **Structural nickel steel.**

803. — *Chemical composition.* — The steel shall conform to the following requirements as to chemical composition:

—	*Structural steel.*	*Rivet steel.*
Carbon	Not over 0.45 %	Not over 0.30 %
Manganese	— — 0.70 %	— — 0.60 %
Phosphorus, Acid	— — 0.05 %	— — 0.04 %
Phosphorus, Basic	— — 0.04 %	— — 0.03 %
Sulphur	— — 0.05 %	— — 0.045 %
Nickel	Not under 3.25 %	Not under 3.25 %

806. — *Tension tests:*

(*a*). — The material shall conform to the requirements as to tensile properties given in table 4.

(*b*). — The yield point shall be determined by the drop of the beam of the testing machine.

TABLE 4.

PROPERTIES CONSIDERED.	*Rivet steel.*	*Plates, shapes and bars.*	*Eye-bar flats and rollers* (3) *unannealed.*	*Eye bar flats* (1) *and plus* (3), *annealed.*
Tensile strength, in pounds per square inch	70 000-80 000	85 000-100 000	95 000-110 000	90 000-105 000
Yield point, minimum in pounds per square inch . .	45 000	50 000	55 000	52 000
Elongation in 8 inches, minimum, percentage	1 500 000 / Tensile strength	1 500 000 (2) / Tensile strength	1 500 000 (2) / Tensile strength	20
Elongation in 2 inches, minimum, percentage	....	....	16	20
Reduction of area, minimum, percentage	40	25	25	35

(1) Tests of annealed specimens of eye-bar flats shall be made for information only.
(2) See article 807 (not reproduced).
(3) Elongation shall be measured in 2 inches.

The proposed rules also contain some useful tables, in particular those giving the equivalent loading due to typical trains.

R. D.

[656 .222.4]

Graphical determination of running of trains, (1)

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Figs. 1 to 5, pp. 1082 to 1085.

A train is moved as a result of the tractive effort of a locomotive. Part of this tractive effort goes to overcome the resistances, while the remainder produces an acceleration of the train, the speed of the train increasing from zero up to a limiting speed which depends on the power of the engine.

If :

S = the tractive effort of the locomotive, in kgr.;

L = the distance run, in metres;

V = the speed, in metres per second;

T = the time in seconds, taken to travel the distance L;

R = the resistance of the train, in kgr.;

Q = the weight of the train in t.;

$M = \frac{Q}{g}$ where g = acceleration due to gravity,

the equation of the applied forces which act on the train is :

$$\int_o^v S dL - \int_o^v R dL = \frac{M}{2} V^2 \quad \ldots (1)$$

During a short period we can consider the variable quantities S and R as constants, and we therefore have :

$$(S - R) L = \frac{M}{2} V^2 \quad \ldots\ldots (2)$$

$S - R$ is therefore the force which produces acceleration during the running of the train.

Of the quantities which appear in equation (2), we know S, which can be determined by calculations, graphically, or by tests made with each locomotive. In the same way we can determine the magnitude of resistance R according to the condition of the track, the weight of the train Q, and the running speed V. We do not, however, know the value of L, and it is therefore necessary to find a graphical construction which allows the distance run to be determined as a function of V and of the known factors.

But
$$M = \frac{1\,000}{9.81} Q,$$

whence
$$\frac{M}{2} = 51\,Q.$$

(1) Published for the first time in the special journal of the Society of Czecho-Slovakian engineers and architects, *Technický Obzor*, 1922.

And since Q is a constant, we can easily determine the value of $\frac{M}{2}V$. If we then construct, as in figure 1, the right angle triangles *oab*, *ocd*, in which

$$oa = V,$$
$$ab = S - R,$$

and

$$oc = \frac{M}{2}V,$$

dc represents L, since the triangles are similar

$$oa : ab = dc : co$$

whence $V : (S - R) = dc : \frac{M}{2}V,$

and therefore

$$dc = \frac{M}{2}\frac{V^2}{S - R} = L.$$

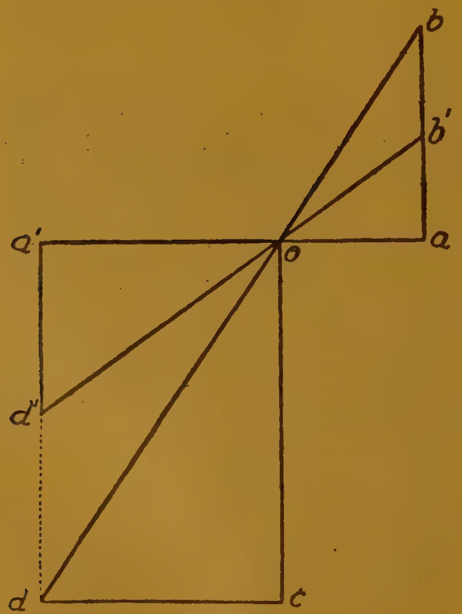


Fig. 1.

L is the distance with the train, acting under the force S, has run from the starting point up to the point at which it has attained the speed V. The train acted upon by this constant force accelerates its speed up to a certain maximum V_{max}.

By joining the extreme points of the horizontal lines *cd*, we obtain the curve of the distances run λ (fig. 2) in the following manner.

On the axis V, set off equal distances, corresponding to the equal increases in speed, and on the vertical lines drawn from their middle points set off the distance S — R. The points of intersection of the straight lines joining the points thus obtained to the origin *o* and of parallel lines drawn at distances $\frac{M}{2}V$ from the axis L determines the curve λ which represents the distance run as a function of the speed.

In representing the run of the train, it is interesting to know, in addition to L the distance run, the time taken in running this distance.

However, from the ordinary equation

$$T = \frac{L}{V},$$

if we set off $ab' = 1$, $a'd'$ is equal to T (fig. 1), since as the triangles *oab'* and *oa'd'* are similar, we have :

$$oa : oa' = ab' : a'd',$$
$$V : L = 1 : a'd',$$
$$a'd' = \frac{L}{V} = T.$$

By this method, we can find for each distance run L, the time T corresponding to the given speed V. The time curve τ (fig. 3) corresponds to the curve of distances λ. This curve τ represents the relation between the distance L, the variable speed V and the time T.

If S — R varies progressively in a uniform manner, as is the case with steam

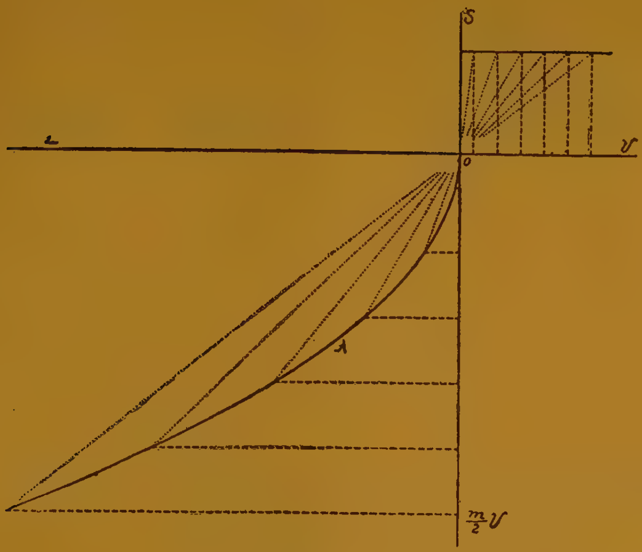


Fig. 2.

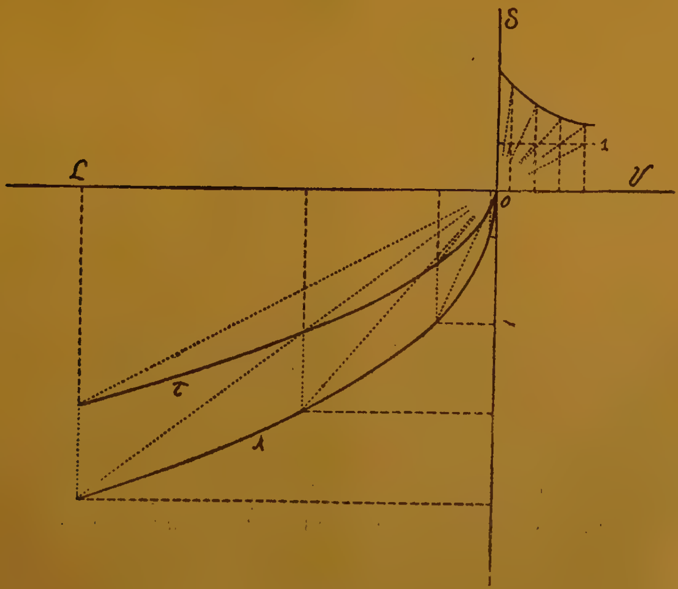


Fig. 3.

locomotives, where S decreases as the speed V increases, we should substitute the curve of figure 3 for the horizontal line of figure 2. Curves λ and τ are constructed in the same way.

If S — R changes suddenly, as for example by the change of resistances R, it is necessary to proceed as in figure 4. For example, suppose the train has attained a certain speed $V = oa$, when the value of $S - R$ changes suddenly, for example from the value *ab* to the value *ac*.

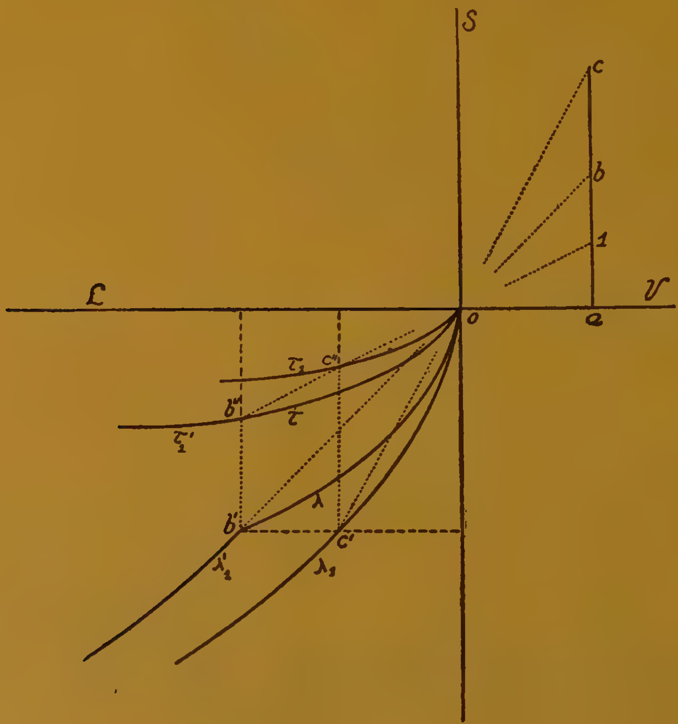


Fig. 4.

Up to the point where the change is made, the curves λ and τ are drawn in the ordinary way. Since if the force $S - R = ac$ had operated since the start, one would have obtained the curves λ_1 and τ_1, it is evident that, up to the point where the sudden change takes place, these curves represent the distance and time taken. It is only necessary therefore to move λ_1 parallel to the axis VL and τ_1 parallel to the straight line $oc'' b''$, in order to obtain the required continuous curves $\lambda\lambda'_1$ and $\tau\tau'_1$ in figure 4.

If the tractive effort falls away until $S - R = o$, the speed will become uniform, V is as constant and λ then becomes parallel to the axis L. At the same time the curve τ becomes a straight line inclined to axis L, the equation of which is $T = \frac{1}{V} L$.

Having done this, if we are dealing with a certain portion of the line ABC (fig. 5),

the graphical representation of the running of the train can be obtained in the following manner :

In the system of axis of xyy', we construct, to the left of the axis of y and above the axis of x, the curve of accelerating forces S — R, obtained by plotting along the axis of x the speeds V. One thus obtains a contour $0a_1\,a_2\,a_3\,a_4\,a_5$. Then from point O set off on the axis of x, to a certain scale, equal lengths corresponding

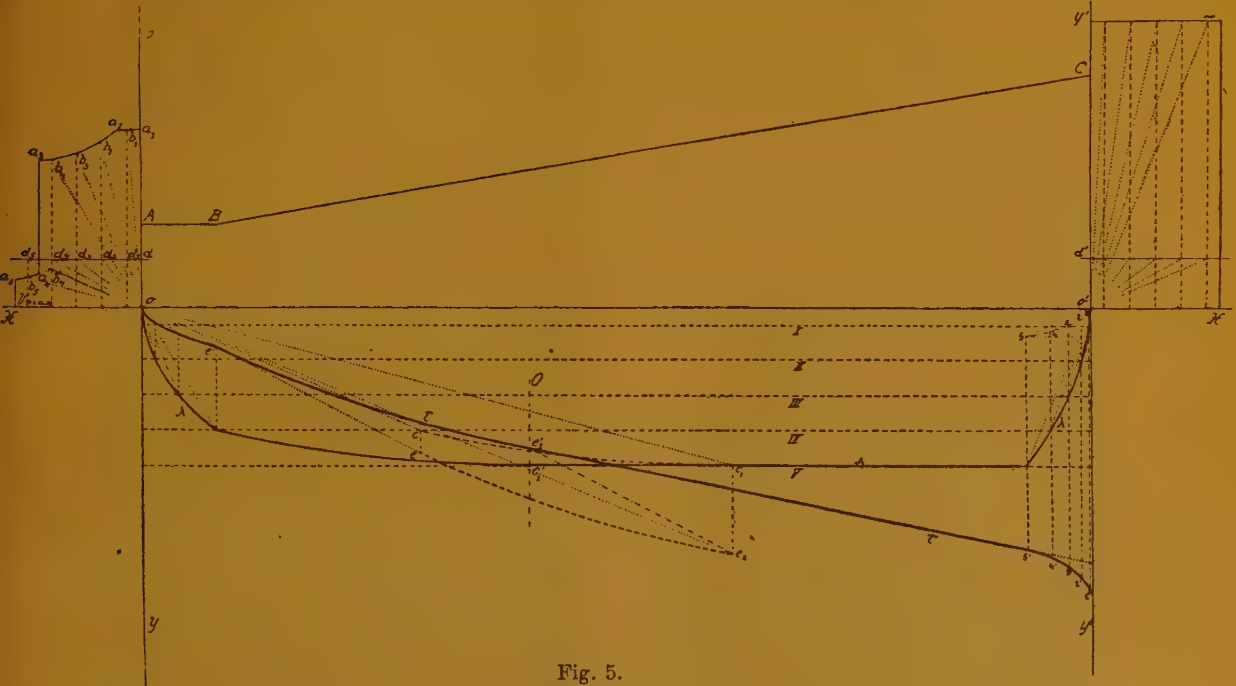


Fig. 5.

to increases of speed. The vertical lines drawn from the centre point of the intervals thus obtained give at the points b_1, b_2, b_3, b_4, b'_4, b'_5, where they intersect the lines $0a_1\,a_2\,a_3\,a_4\,a_5$ the values of the accelerating force S — R, for the section of track AB. These vertical lines correspond to the *average speeds* which we have taken as constant in the narrow limits of the short periods under consideration. In the same way one may take as being constant over each period the average force S — R.

Below the axis of x, set off along the axis of y, lengths representing $\frac{M}{2}$ V, corresponding to the average speeds as obtained above and draw parallel lines to the axis of x. numbered successively I, II, III, IV, V. The straight lines joining the origin O to the points b_1, b_2, b_3, b_4 determine, where they meet these parallel lines, the lengths L and the points of intersection are points of the curve of distances λ. By this construction, we come to the point B on the track, where in consequence of the gradient, R becomes greater and consequently the force S — R is reduced

to the quantity $a_3 a_4$. We then obtain new points c and c_1 on the line λ at the intersection of the straight lines $b_4 o$, $b_5 o$ and IV, V. We then shift this portion of the curve λ parallel to the axis of x until the point c coincides with the points on the parallel line IV, and the first part of the curve λ. As at c_1, the maximum permitted speed V_{max} is obtained, the line λ at the final point c'_1 becomes a straight line parallel to the axis of x. The driver should therefore, by reducing the supply of steam to the cylinders, satisfy the equation $S - R = o$, $S = R$, and in consequence V is a constant and equal to V_{max}.

The line of speed (having L and T as co-ordinates) is obtained by drawing to the distance $od = 1$, set off above the axis of x, a parallel line which meets the ordinates of the mean speeds at the points d_1, d_2, d_3, d_4, d_5.

The straight lines joining these points to the origin O cuts the vertical lines drawn from the corresponding points on the curve λ at points which lie on curve τ. We know that we must now shift the part ee_1 of this line to $e'e'_1$, along the straight line d_4O, which is produced as ee'. From the point e'_1, τ should be a straight line, because λ is also a straight line. The angle of this part of the curve τ and the axis of x depends on the ratio $\frac{V_{max}}{L}$. It may be pointed out in passing that in consequence of the relation which exists between the curves λ and τ, the points c'_1 and e'_1 should lie upon the same vertical line.

If the train approaches a stopping place C, it is necessary to dissipate by a brake application the kinetic energy $\frac{M}{2} V^2$. This process is a converse of that which is obtained when starting the train, the force at starting being equal and opposite in sign to the braking force increased by the whole of resistances R. We therefore set off on the axis y' a distance corresponding to the force Z, which is the sum of the force due to braking and the resistance to motion along the portion of track BC. Construction is carried out as if the train commenced to move at C in a direction towards B. The curve λ is drawn from the axis y, but obviously in the inverse direction.

The speed movement 0′, 1, 2, 3, 4, 5 gives us, by the difference in the ordinates at the various points, the relative loss of time for a uniform speed and when a brake application is made, and by setting off these intervals of time on the vertical lines below the straight portion of the curve we obtain at 1′, 2′, 3′, 4′, 5′ the latter part of the curve of running up to the axis y'.

We have thus determined accurately and completely the running of the train on the portion of track AC.

The line τ marks off on the axis y' a distance proportional to the time taken in running the whole distance from station A to the station B. The latter part of the curve λ gives in the same way the length of the line over which the brakes are applied, the force due to brake application being Z — R and the weight of the train Q. The curve λ also allows the speed of the train to be determined at any point on the track. The ordinates of λ, which depend on the values of $\frac{M}{2}$ V and which are measured from the axis x correspond in every case to a certain value of V.

[625 .13]

Some examples of the provision for ventilation of tunnels and subways

Figs. 1 to 9, pp. 1090 to 1096.

(*The Railway Engineer.*)

Several serious accidents in tunnels have occurred owing to imperfect ventilation. The most recent is perhaps that in a single line tunnel on the Paris, Lyons & Mediterranean Railway between Bourg and Bellegarde. A luggage train with two engines broke down in the tunnel, and a passenger train following found the luggage train stationary on the line, the result of the approach of the passenger train being a slight collision. Five guards, together with the engine driver and stoker, were found to be all dead, whilst another stoker was lying unconscious, the result of suffocation. These eight men were found lying in different points of the tunnel between the stalled train and the portal as though they had tried to struggle out of the poisonous fumes. So dangerous were the breathing conditions when the passenger train reached the stalled goods train that the driver and conductor had to run their trains backwards to the open air beyond the portal to save the passengers from being suffocated.

Some time ago a Royal train with two engines arrived at the upper exit of the Pracchia tunnel on the Bologna-Florence line, which is 3 000 yards long, with both engine men and both firemen insensible through the noxious fumes of the tunnel. At the Ponte Decimo tunnel near Genoa 12 persons were killed and 40 injured in an accident which was the direct result of bad air. A heavy goods train with three engines were going through the tunnel, when from some cause the engines slipped and the train came to rest in the tunnel and this unfortunately on a steep gradient. All the drivers and firemen were rendered insensible, and the train ran back to the lower end of the tunnel and crashed into a passenger train which was waiting to ascend the gradient. Within the St. Clair tunnel on the Grand Trunk Railway, six employees of the railway were killed by gas and smoke from a locomotive standing in the tunnel on account of the train breaking in two.

Discomfort is caused as much by humidity as by heat in many cases, and although it cannot be expected that the air of town subways will be as cool and pure as that of the streets above, any more than the air of the streets will be as fresh and pleasant as that of the country, yet the conditions in some cases have been exceedingly uncomfortable even when not immediately dangerous to life. In the old days the amount of carbon dioxide in the Metropolitan Railway in London was found to reach 86 parts per 10 000.

These conditions also render the wear of rails exceedingly rapid, in some cases 6 to 10 times as great as when out in the open. In the Box tunnel the wear and corrosion amounted at one point to 2 1/2 lb. per yard per annum, this wear being found over the whole surface of the rail. At one point in the Severn tunnel the wear of rails amounted to 2 3/4 lb. per yard per annum, and this when the wear on rails in the open

country was only about 1/4 lb. per yard per annum.

In some cases a specially heavy form of rail has been adopted in tunnels, and in many other cases the rails have been specially tarred or painted to preserve them from the injurious fumes. At the Severn tunnel the experiment was made of boxing up the rails with ballast to a height of 1 or 1 1/2 inches below the top of the rails, but the remedy was found to have worse effects than the disease. If broken stone ballast is used in tunnels it is generally in an unclean condition soon after it is laid down, and it is sometimes a question whether the ballast could not be replaced by concrete, or some other material having a smooth surface, that could be flushed clean whenever necessary.

Some ventilation expedients.

The shafts made for the construction of tunnels are usually left open for ventilation purposes. The Edge Hill tunnel, near Liverpool, was kept free of vitiated air by a fan in the centre of the tunnel. In the case of the Severn tunnel vertical shafts were sunk on both sides of the estuary, and the ventilation was effected by fans 40 feet diameter and 12 feet wide. At the Mersey tunnel a special circular heading, 7 ft. 4 in. diameter, was driven from Birkenhead and from Liverpool (a length of about 2 250 yards) to a point in the centre of the river, which is, of course, also the lowest point of the tunnel and the vitiated air was removed by means of this heading to fans placed on each side of the river.

The total capacity of the four fans amounted to about one-seventh of the total cubic content of the tunnel. The fans were 40 feet diameter and 12 feet wide, exhausting 130 000 cubic feet of air per minute; and 30 feet diameter and 10 feet wide, exhausting 120 000 cubic feet of air per minute, one of each size at Birkenhead and Liverpool respectively. For ventilating purposes the tunnel is divided into four sections, one fan being allotted to each section, but through the medium of doors the fans could be used to do each other's duty as might be required. As the noxious air was removed in this way from the centre of the tunnel, fresh air flowed in from the stations at each end of the tunnel and from two pumping shafts. At each of the openings connecting the tunnel with the special air heading, sliding doors were placed for regulating the volume of air passing through, so that the air could be extracted from any required point. The tunnel is now electrically operated, but when steam was used the airway became encrusted with soot, which in some places was 3 inches in thickness.

The Simplon tunnel (12 1/3 miles long) was provided with a steel sliding door at each portal, which was raised and lowered by electric power. The system was to lower the steel door after the entrance of a train, and then to force fresh air at considerable pressure into and through the tunnel from fans placed at that end of the tunnel. The adoption of electrical working of trains has, however, greatly simplified the problem of ventilation.

The Mount Cenis tunnel (8 1/4 miles in length) has gradients of 1 in 40, ascending into the tunnel from each end, and this raising of the line within the tunnel comprises the ventilation to some extent. At the Bardonecchia entrance an installation of seven overshot water wheels, 16.4 feet in diameter and 19.7 feet in width, worked air compressors which forced fresh air into a pipe and discharged it at points 3 280 feet apart along the tunnel. This arrangement was of great use to the men working in the tunnel, but was not sufficiently powerful to ventilate the tunnel efficiently.

The St. Gothard tunnel (9 1/3 miles long) was ventilated by the Saccardo

system laid down at Goeschenen. Two ventilators, 16 feet diameter, were provided with an annular air chamber in the interior of the tunnel, the plant being driven by a 450-H. P. steam engine. This installation was planned to drive into the tunnel 413 000 cubic feet of fresh air per minute, with a current of 686 feet per minute.

In the case of the Metropolitan railways in London, an Act of Parliament gave the companies the right to construct ventilators (known as blow-holes) in the roads and spaces the railway passed under. Fans were laid down at various points where blow-holes were impossible, one between Cannon Street and Monument, 18 feet diameter, 4 feet wide (see figure 1), another between Monument and Mark Lane, 15 feet diameter, 5 ft. 6 in. wide (see figure 2), and another in the Whitechapel Road. Gas engines drove the fans at 60 runs per minute, and each expelled about 70 000 cubic feet per minute by means of a chimney or shaft, which was made at least as high as the adjoining buildings. It was found, however, that the undulatory motion given to the air when driven through the fans was the cause of much vibration, and the Chancery Court granted an unjunction to stop the use of the fans.

For the Central London Railway, which was originally 6 miles long from Shepherd's Bush to the Bank, the natural ventilation was by means of stairways and lifts at each station; but in addition to this, mechanical ventilation was secured by an exhausting fan at Shepherd's Bush station, drawing in fresh air from the intermediate stations and from the other end of the tunnel. This fan was 20 feet diameter, 5 feet wide, and was electric at a speed of 145 runs per minute, with a capacity of 100 000 cubic feet per minute.

The Great Northern & City Railway had the usual ventilation by two stairways and three lifts at each station. Artificial ventilation was also added by a fan of 1 000 000 cubic feet per hour capacity, situated 6 330 feet from the Moorgate end of the tubes. This fan forced fresh air through a heading, 10 feet diameter, into the up tube to Moorgate Station, and from thence the current of air was turned into the down tube, in both cases in the direction of the movement of the trains.

The Boston subway.

In the Boston subway, although electrically operated, about 4 1/3 miles of the length is ventilated by the system of admission of fresh air at stations and portals, and the extraction of foul air by exhaust fans at certain points between the fresh-air inlets. The foul air is conducted through ventilating ducts to the ends of the tunnel, the ducts having a cross-sectional area of 48 square feet, and being formed in the upper part of the tunnel. The diaphragm enclosing the foul air passage was made of a layer of expanded metal covered with cement mortar, the diaphragm being only 1 inch in thickness. The foul air duct is divided in the middle of its length into two lengths leading to the portals, and openings are provided at frequent intervals for the admission of the vitiated air, which eventually leaves the duct by grated openings at each extremity of the channel.

It is a question whether it would not be better in such a case to provide the duct for ventilating purposes entirely outside and independent of the tunnel cross-section, as was done in the Mersey tunnel at Liverpool.

The Allegheny Summit tunnel.

The Allegheny Summit tunnel, which has a length between the portals of 5 176 feet, is ventilated by means of a large specially built nozzle and other plant at the east end. Two large fans are provided, one on each side of the

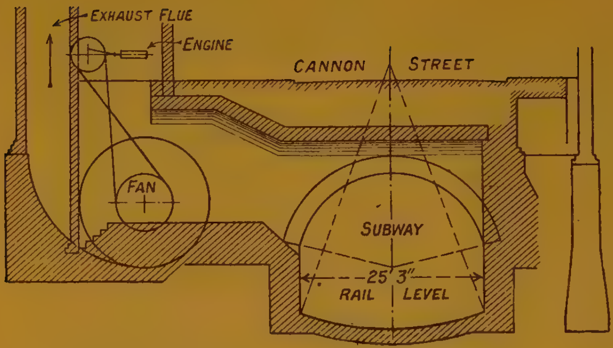


Fig. 1. — Ventilation equipment as originally constructed under Cannon Street, London.

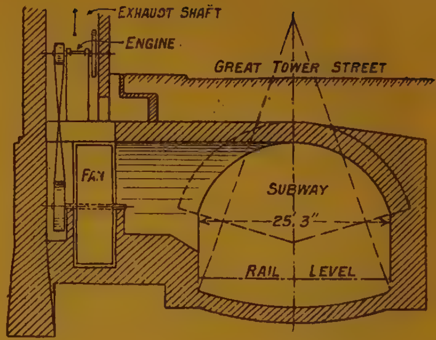


Fig. 2. — Ventilation equipment as originally constructed under Great Tower Street, London.

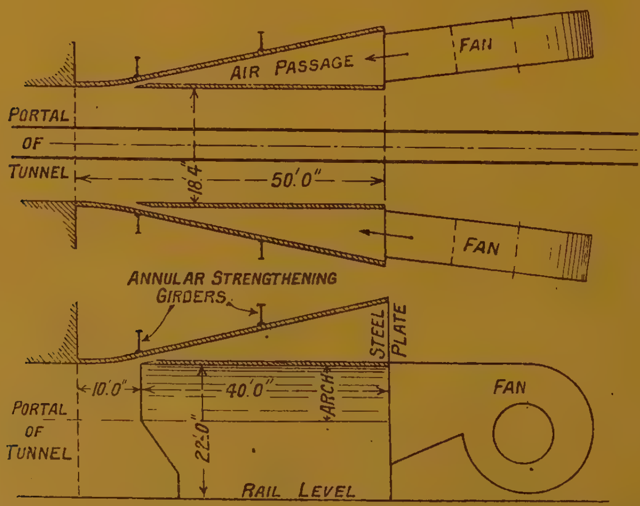


Fig. 3. — Plan and section of nozzle at portal of Allegheny Summit tunnel.

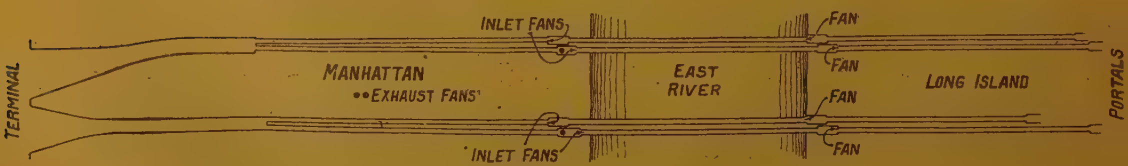


Fig. 4. — Diagram showing position of the ventilating fans.

railway, each driven by an electric motor. The two fans force fresh air through sheet-iron ducts between the fans and the nozzle into the end of the tunnel, and as the air is forced through the ducts the opening is reduced in area or tapered, which has the effect of admitting the air into the tunnel at a high velocity.

As the trains enter the tunnel at this end under full steam, and those in the opposite direction leave it generally running free of steam, the smoke and other gases produced by the engines are driven ahead by the air forced into the tunnel end. The ventilating plant was made to deliver 590 000 cubic feet of air per minute through the nozzle, causing a velocity of air through the tunnel of 1 600 feet per minute. The fans are multivane and are 9 ft. 8 1/2 in. in diameter and 6 ft. 8 1/4 in. in width. They are constructed of 7/8 inch steel plates and are worked by motors at a voltage of 2 300, transformed from E. H. T. supply at 88 000 volts.

The blowing nozzle (see figure 3) is 50 feet in length outside the tunnel, the outer casing and the casing of the ducts from the fans being of steel plates 1/8 inch thick; and the inner casing, which conforms to the outline of the tunnel, is made up of 3-inch tongued and grooved yellow pine. The fans only operate for the west-bound trains which work through the tunnel under steam, and the time of running is ordinarily less than 10 minutes. The speed of these trains is regulated to 14 miles per hour, and it is found that the fans easily drive the smoke ahead of the engines when they are travelling at this speed.

The Pennsylvania tunnels at New York.

It was necessary to provide ventilation for 15 1/2 miles of tunnels, including those under the Hudson River and the East River, and under the full width of Manhattan Island.

It was decided to maintain a standard of purity in the cars of not more than eight parts of carbon dioxide in 10 000 parts of air, equivalent to providing 30 to 50 cubic feet of air per minute to each passenger, and approximating in the tunnel under the East River to a 20 minutes' change of air. The fresh air was introduced in a constant flow at the points indicated in figure 4. A divided nozzle was introduced so that the air could be delivered on each side of the tunnel, in the direction of the traffic, through expanding outlets placed in the bench walls. A decided injector effect was produced by the expanding outlets, causing a strong current from the portal to the fan, 750 feet within, and thence along the tunnel and in the direction of the traffic throughout.

Of the 14 fan outlets, 12 are used as fresh-air supply fans, and the other two are for exhausting the vitiated air, the position being shown on the figure. They were so arranged that the vitiated air did not enter the stations, and each tube is separately ventilated so that there should be no bye-passing of air between the tunnels. There are no obstructing ducts in the tunnels, the side benches being left for footwalks. The fans are from 4 ft. 6 in. to 6 feet in diameter, with multiple drum wheels and a capacity of 59 200 to 125 800 cubic feet per minute and are belted to electric motors with three-step cone pulleys for speed variation. The length of tunnel ventilated varies from 3 900 to 6 600 feet, and the average air velocity due to the fans alone was about 8 miles per hour, which has been increased to 30 miles per hour by the piston action of the trains.

The Battery Park tunnels.

The two Battery tunnels of the New York subway extension to Brooklyn are two single track tubes 15 1/2 feet diameter internally, about 6 750 feet in length, and from 26 to 28 feet apart on centres. Each tube has a gradient of 1 in 32 down to a vertical curve in the

centre of the East River, the tops of the tubes being about 80 feet below mean high water level.

The ventilation of the tunnels is to a great extent taken care of in the piston effect of the trains travelling always in the same direction in the tubes. To assist in this, large openings were left at the shore ends of the tubes, to allow access of fresh air at the rear of the trains, and for discharge of vitiated air in front of the trains. But for emergency conditions a system of mechanical ventilation was provided that could be used continuously if necessary.

The blower equipments could, of course, only be placed at the shore ends of the subaqueous tubes, and another difficulty was that there was little room at the side of the loading gauge for the installation of nozzles of sufficient size to provide an effective blast. Narrow nozzles pointing in the direction of the traffic were provided in the restricted area at each side of the tunnel, and these were connected up to fans as shown in figures 5 and 6.

It was thought necessary to provide a volume of 45 000 to 50 000 cubic feet per minute for each tube, with a slight in-

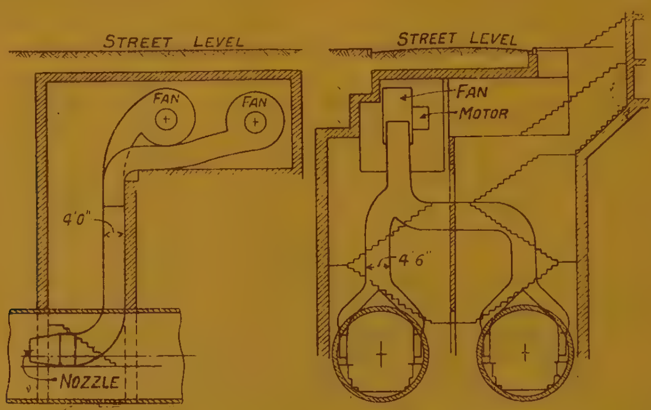


Fig. 5. — Longitudinal and cross sections, showing arrangement at Battery Park tunnels.

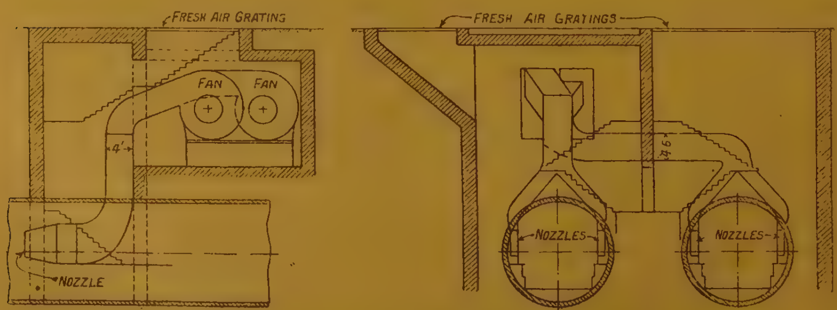


Fig. 6. — Longitudinal and cross sections, showing ventilation arrangements of the Battery Park tunnels.

crease in this capacity for emergency conditions. The nozzles on each side of the tunnels have an orifice area of 5 square feet, each tube thus having a

total nozzle capacity of 10 square feet and a delivery duct of 18 square feet cross-sectional area. The blowers were centrifugal downward discharge fans having a diameter of 7 feet, a width of 4 feet, and a capacity for delivering 46 500 cubic feet per minute. The fans were installed in duplicate at each blower station, in order that in no condition should it be impossible to use at least one fan in running condition in each station. Each blower is connected to a 75 H. P. direct-connected motor driving the fan at a speed of from 300 to 413 runs per minute, and being operated from the 600-volt supply of the subway system. The blower equipment is housed in each case in an underground chamber, which is connected to the tunnels by a vertical shaft having a width of 14 feet parallel to the tunnels and from 45 to 52 feet transversely to the tubes. The depth from the surface of the ground to the top of the tunnel varies from 25 1/2 to 48 feet.

Each shaft is divided vertically by a partition wall, so that the opening to either tube is independent, and either may act as an exhaust should this be required. The top of the shaft is in each case left open to the outer air and is covered by a grating. The fans have their own intake from the outside air similar to those for the exhaust, and iron staircases are provided for access to all parts of the equipment. The fans and nozzles are connected by a rectangular duct of galvanised iron, which has cross branches connecting with other nozzles for a reversal of flow in the tubes should this be necessary.

The main ducts have a cross-sectional area of 18 square feet (4 1/2 by 4 feet), which is divided by a Y-connection into two ducts of 9 square feet sectional area, one on each side of the tunnel. Valves are provided within the air ducts to permit either of the two fans to propel the air independently, whilst if it is required to use both fans at the same time, the valve will assume a central position, and in this way will not interfere with the work of either of the fans.

The valve mechanism in both stations is under direct distant electric control, an arrangement that also permits of the direction of flow being instantly reversed should this become necessary. Normally, the piston effect of the moving trains should be all that is required for the efficient ventilation of the tunnels, but should any emergency occur such as the stoppage of the train within the tunnel, or if dense smoke is caused by the burning out of a motor, or by deranged electrical apparatus, then communication can at once be made from any one of a series of telephone stations that have been provided at intervals of 300 feet throughout both tunnels.

These telephones connect to a central office from which the fans at each end of the tunnel are directly controlled. The currents of air can be thus reversed or strengthened, or if the fans are not at work they can be instantly actuated as may be necessary for the comfort of passengers in the trains or workmen engaged in the tunnels. There is no danger from fire in the tunnels as the cars are all of metalled construction.

The Hudson tunnels.

The Hudson tunnels of the Hudson & Manhattan Railway are ventilated by means of a fan and shaft situated at Washington Street in Jersey City, N. J. The fan is of the Sirocco type and exhausts the air from two tunnels at different levels, one of which is circular in section and the other having vertical sides and arched roof, special airways being constructed as shown in figure 7. The shaft was previously sunk for construction purposes, and is about midway in the length of the two tunnels that it ventilates.

The blast wheel of the fan is 6 ft. 6 in. in diameter, 6 ft. 6 in. in width, and contains 64 blades. A 40-H. P. motor is

directly connected to the shaft of the fan, which is driven at a speed from 175 to 200 runs per minute under a 600-volt direct current. The actual tests gave a brake horse-power of from 27.7 to 39 under a voltage of 615 and speed of

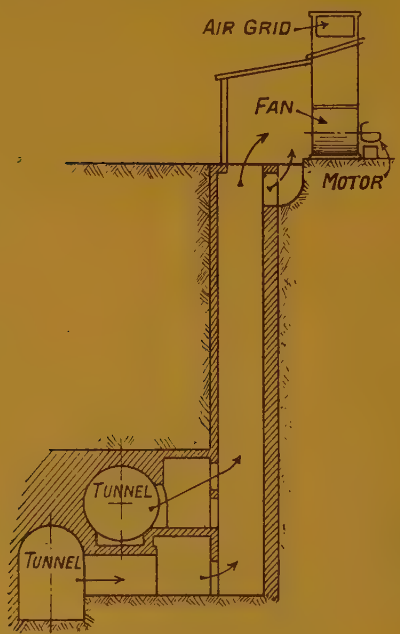


Fig. 7. — Vertical section of ventilating shaft to the Hudson tunnels.

175 to 200 runs per minute. The fan was estimated to draw air out of the tunnels at the rate of 6 000 000 cubic feet of air per hour, and actually was found under test to exhaust at the rate of 109 000 to 133 000 cubic feet per minute. The discharge was through a screened outlet hood as shown.

The Washington terminal tunnel.

The new Union terminal tunnel at Washington, D. C., was ventilated by an equipment that could be placed within a very restricted space only, within and on the same level as the tunnel itself. It was desired that all traces of smoke and gas left by one passing train should be removed before a second train should enter the tunnel, and the point where the fans could be laid down was some 300 feet within the terminal portal.

Two fans of the Sirocco type, each of 10 feet diameter, and each capable of delivering 260 000 cubic feet per minute, were placed at this point, and were to be worked at a speed of 145 runs per minute, with a power requirement not to exceed 120 H. P. From the fans two ventilating ducts were provided along both sides of the tunnel, each being 18 feet high and 5 feet wide, the two ducts being connected by a cross duct under the railway lines.

The Sirocco type of blower has been found most suitable for this kind of work. The blades of the fan are very short radially being only one-sixteenth of the diameter of the fan whilst axially the blades are three-fifths of the diameter. The best results are obtained, no matter what the size of the blower may be, with an arrangement of 64 blades. These blades are bent forward to a set angle in the direction of the rotation, and are sligthly capped.

The inlet and outlet are made about equal to the area of the fan itself, and the advantage of the type is that power-absorbing eddies are almost entirely eliminated, whilst the velocity of the air is so greatly accelerated that it exceeds the peripheral speed of the blades to as much as 70 %, and the intake draught shows practically no variation over its entire area. If the ordinary type of fan had been adopted for the same output of air it would have been of 17 feet diameter, a size of fan for which there was insufficient space.

The Baltimore tunnels.

The tunnels of the Philadelphia, Baltimore & Washington Railway under Wilson Street in the City of Baltimore

consist of two tunnels 4 963 feet and 2 190 feet in length, each being made for a double track, and arched over. The development of the ventilating equipments forms an interesting study. Owing to heavy gradients the trains had to be double-headed in one direction through the longer tunnel, making some kind of artificial ventilation a necessity. The shorter tunnel had no such steep gradient, and special means of ventilation were not necessary in this case.

The ventilation of the 4 963-foot tunnel had been a problem for some time. In 1892 a fan and chimney stack for exhausting the smoke and fumes were set up at a point in Wilson Street about midway along the length of the tunnel, and at the same time a power house for driving this equipment was provided at the north portal. The fan house in Wilson Street contained a 70-H. P. motor driving a horizontal fan at the base of the chimney stack at a speed of 124 runs per minute, which was connected to the tunnel by a duct. The chimney was originally 100 feet in height and was subsequently raised to 150 feet. The power house at the north portal contained a 100-H. P. tubular boiler, and a horizontal engine driving a 550-volt direct-current 75-H. P. generator.

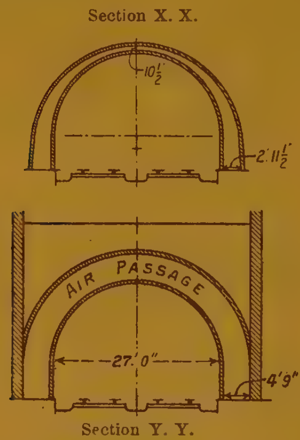
In 1902 this equipment was found inadequate, and two vertical fans with a chimney stack, 150 feet in height and 12 feet in diameter at the top, were set up at another point nearer the north portal. The second set of fans were 15 feet in diameter and 7 ft. 6 in. in width, belt-driven by 40-H. P. motors, and having a capacity of 110 000 cubic feet per minute.

The additional plant consisted of another 250-H. P. boiler and a direct-coupled engine generator set consisting of a 16 by 25 inches tandem-compound engine with a 150 kw. 525 to 575-volt direct-current generator. At the same time the old motor in the first fan house in Wilson Street was replaced by a new 80-H. P. motor. It was then found that the quantity of fresh air entering the north portal, with the total power at work, amounted to 264 000 cubic feet of air per minute. The old fan was removing 239 750 cubic feet and the new fans 283 000 cubic feet of vitiated air per minute from the tunnel. Even with these conditions it was found that the air in the tunnel was not satisfactory, especially when one of the fans had to be closed down for repairs.

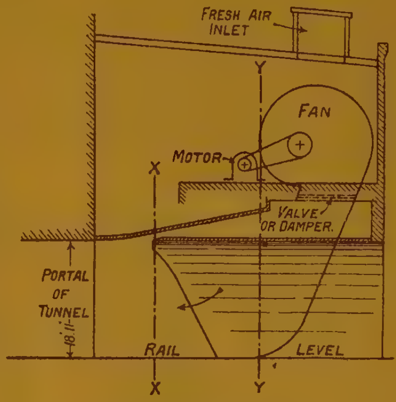
In 1908 duplicate equipment was laid down at all points, and at the first and oldest fan house in Wilson Street a vertical exhaust fan, 15 feet diameter and 7 ft. 6 in. wide, driven by a 100-H. P. motor, was installed and connected to the old 150-feet chimney by a special flue entering the stack at a point above the old horizontal fan which was first laid down. The new vertical fan at this point had a capacity of 160 000 cubic feet per minute at a speed of 100 runs per minute. In 1909 it was found that when coke had to be used on the engine instead of coal, a pocket of gas, sometimes varying in position under weather and the piston action of trains, existed in the tunnel between the two fan equipments, and the whole question of ventilation was dealt with again in a radical manner.

It was then decided that the previous method of ventilation by means of chimney stacks, even with mechanical means of assisting the exhaust of vitiated air, was unsatisfactory. The trains would sometimes block the intakes to the fans, and the current of air from the portal would often be made ineffective by the passage of the trains or by atmospheric conditions. It was then suggested by the engineers that it would be wise to introduce fresh air into the tunnel by means of fans driving air through a nozzle surrounding the tunnel opening, a system that had already been introduced with advantage in several European tunnels. The nozzle was to be placed at the south end of the tunnel so as to drive the fumes to the north portal and the tall chimney,

which were in a non-residential district, and although the weight of traffic was in the opposite direction.



Section of ventilation nozzles at the portal of Baltimore tunnel.



Longitudinal section through axis of tunnel.

Fig. 8.

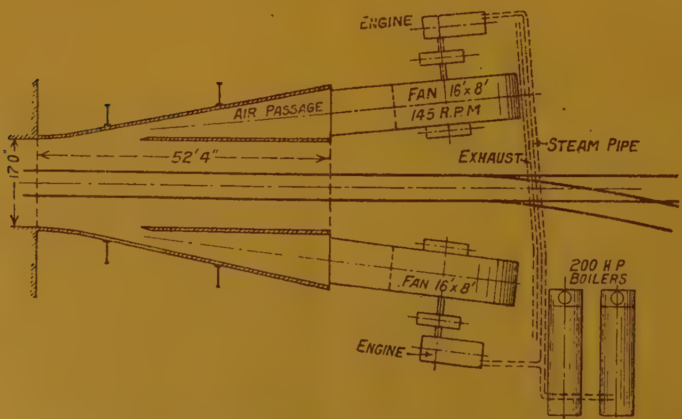


Fig. 9. — Plan of the ventilation nozzle at Gallitzen tunnel.

In the meantime all the drivers and guards were provided with air respirators, which were made of a metal cone fitting over the mouth and nose, and provided with a damp sponge at the apex of the cone, the respirators being connected to a reservoir on the engine. A 5-inch lead pipe in a wooden trough was also placed against the wall of the tunnel for a length of 900 feet from the Wilson Street fan, and provided with outlets at intervals along this length. The fresh air was driven through this pipe by a blower having a capacity of 300 cubic feet per minute, at a speed of 450 runs per minute, and belt-driven from a 7 1/2-H. P. motor.

In 1910 a heavier class of engine had to be used for the trains, and it was then found that during the passage through the tunnel the heat sometimes rose in the cabs of the engines to 150° Fahr., so that it became once more imperative to deal with the problem of efficient ventilation. The system of fans driving through a carefully shaped nozzle at the south end of the tunnel, and as shown in figure 8, was then adopted. The blowers are in two separate units, each capable of delivering 450 000 cubic feet of air per minute at 104 runs per minute, and providing a complete change of air in the tunnel every 47 minutes.

It was also determined to do away with the original fan house and chimney stack in Wilson Street, which, being in a residential district, was always objectionable. The fans near the north end of the tunnel were also altered to the multivane type which would only allow highly diluted gases to pass out of the north portal. At the south portal the fans were placed above and outside of the end of the tunnel. The fans were of the Sirocco type, and were 10 ft. 6 in. diameter, 10 ft. 6 in. width, require 190 H.P. per fan, and have 13 1/2-inch shafts.

The two electrical motors were each of 235 H. P., and ran at a speed of 600 runs per minute and at a pressure of 2 200 volts. The blast of air is directed down into a chamber surrounding the tunnel which gradually diminishes in size to form the nozzle for discharging the air into the tunnel. The width of this air chamber tapers from a uniform width of 4 ft. 9 in. directly below the fans, to the opening into the tunnel end, where the width varies from 2 ft. 11 1/2 in. at the rail level to 10 1/2 inches at the crown of the arch.

At the north end of the tunnel, where new fans of the multivane type were laid down, the blower capacity was increased to 200 000 cubic feet per minute at a speed of 65 runs per minute with 35-H. P. motors. As the new equipment required power beyond the capacity of the old electric installation the plant producing the 550-volt direct-current was abandoned, and alternating current was obtained from another source, the voltage being transformed from 2 200 to 220 as required for the new motors.

The lay-out of a similar ventilating equipment at the Gallitzen tunnel is shown in figure 9.

[621 .131]

Development of the locomotive, (1)

By Sir HENRY FOWLER, K. B. E.,

DEPUTY CHIEF MECHANICAL ENGINEER, LONDON MIDLAND & SCOTTISH RAILWAY.

(Modern Transport.)

We are perhaps too apt at the present time to forget the obligation which the world owes to transportation, so commonplace have the improved methods become. We are already forgetting the lesson that the submarine menace gave us on this matter during the war, and again looking upon the movement of

(1) Abstract from an address entitled : « Transport and its indebtedness to science », delivered at a meeting of the British Association, at Liverpool, on 14 September 1923.

matter from point to point as a commonplace occurrence. It has been said that effective transportation is one of the great aids to civilisation, but it must not be forgotten that all movement of material from place to place is economically waste so far as the dissipation of work is concerned. Problems of transportation have been solved more or less successfully in all ages, and some of them, such as moving of the stone to Stonehenge, still excite our wonder and admiration. Such works, and similar ones of much greater magnitude in the East, however, we feel as engineers could be accomplished by quite crude methods if there were unlimited labour available, and if time were of no consequence. The transportation which aids civilisation is that which cuts down the wastage of power to a minimum and which reduces the time occupied in carrying this out. It is here that science has helped in times past, and will help increasingly in the future if we are to go forward. In no other branch is Telford's dictum that the science of engineering is « the art of directing the great sources of power in nature for the use and convenience of man » so well exemplified, and this utilisation has been carried forward at ever-increasing speed during the last hundred years. Dealing with transport, it may be said, roughly, that it is mainly dependent upon three things — the method of propulsion, the material available for use, and the path over which traction takes place. I cannot deal fully even with one of these, and propose to confine my remarks to the first two, which are the ones I am best acquainted with.

The greatest step.

It may be said that advance in traction really became rapid when methods of propulsion other than those of animals and the force of the wind became available. The greatest step forward — wonderful as some of the achievements of aeronautics have been of recent years — came with the development of the steam engine. Like most great achievements in the world, it was not a lucky and sudden discovery of one individual; although here, as elsewhere, we associate the work with the name of one man especially. This has usually been the case, and without wishing to detract from the work of the individuals who are fortunate enough to utilise the ordered knowledge available to the practical use of man, one must not forget the labours of those who have sought out that knowledge and have given it freely to the world; thus placing it at the disposal of the one whose imagination and creative faculty were great enough to see how it could be utilised in the service of man.

Early experiments.

The first attempt at traction by using a steam engine was a failure. I refer to the work of Jonathan Hulls and his attempt, in 1736-1737, to apply one to the propulsion of a boat on the River Avon in Worcestershire. He failed because of the lack of that knowledge, although, undoubtedly, he possessed the necessary imagination. Although James Watt is not directly associated with traction, it was his application of science to practical use that finally gave the greatest impulse to transportation that it has ever had. No advance had taken place to Newcomen's engine of 1720 until Watt's work of 1769. His knowledge of Black's work at Glasgow on the latent heat of steam, and his own experiments with the Newcomen model, led to the success of his improvements of the steam engine. His scientific knowledge is clearly shown in his patents and publications; for he dealt with steam jacketing in 1769, with expansive working in 1782, and he devised his parallel

motion in 1784. His direct connection with transport includes the reference to a steam carriage and a screw propeller in 1784, whilst the firm of Boulton and Watt corresponded with Fulton for a period extending from 1794 to 1805. Although Cugnot, in 1770, and Murdoch, in 1786, had made models of vehicles propelled by steam, it was Richard Trevithick, with his steam carriage in 1801 and 1803 and ill-fated railway in 1804, who first showed the practical application which could be made. It is probable that the engine which his assistant, Steel, took to the wagon-way at Wylam, in 1805, turned the thoughts of George Stephenson to the work that has meant so much for us. No one can read the early life of the father of railways without appreciating that he was from young manhood a searcher after scientific knowledge. The advances he gave to the world of transport were all due to his practical application of the knowledge he had obtained himself, or had learned from others. It is so often thought that, because the early inventors and engineers of the beginning of last century had not received what we now call a scientific education, they were not in any sense of the term men of science. It must be remembered that at that time the knowledge of natural phenomena was very limited, and it was possible to know much more easily all the information available on a subject than at the present day, when we have such a mass of miscellaneous information to hand on every conceivable subject. It was ordered knowledge which led Stephenson to adopt the blast-pipe of Trevithick. It was the desirability of obtaining ordered knowledge that caused him to carry out those experiments which showed to him the advantages of using rails, and it was the scientific appreciation of the necessity of increased heating surface that made him adopt the suggestion of using tubes through the water space in the boiler of the « Rocket ».

Superheated steam.

From the time of Stephenson, the progress in propulsion on rails by steam locomotives was steady, if slow. The investigations for a long while were largely confined to the question of expansion and condensation and, although the results attained were noteworthy in the case of steamships, on the rail — to which for the moment I will confine myself — there was little advance in the principle of propulsion. On the other hand, the improvements in materials allowed a steady growth in power and size. Although work was done by compounding and using higher pressures, the greatest advance has come to steam locomotives by the use of superheated steam. This was no new thing, for Papin, in 1705, seemed to have an appreciation of its value. As pressures and the resultant temperatures increased, there came difficulties with lubrication. With the increased use and knowledge of mineral lubricants, Dr. Schmidt was, in 1895, able to devise methods of using superheated steam which have been of the greatest use to transport and to the community.

The turbine.

In spite of the fact that the idea of the utilisation of steam for giving rotary motion is old, its commercial adaptation in the turbine is modern. Rarely, if ever, has there been such a direct and instantaneous application of science to practice. We are too close at present to the matter to realise what a change has taken place in the world owing to the introduction of the steam turbine. Apart from its application to marine work, it is the turbine which has made possible the economical production of electrical energy, which is doing so much, and will do so much more in the future, for rail transport. To-day, it may be said, as if often has been, that

there are no mechanical or electrical difficulties in the electrification of railways, the only difficulties being financial ones; although one could hope that the induction troubles could be overcome by a cheaper method than at present available.

Electrical traction.

It is impossible here to trace the development of electrical science from the experiments described by Gilbert in 1600 to the equipment of electric locomotives on the railways of Switzerland and the United States of America. One must mention, however, what a change electrical traction by train and tube has made to our town life. It has rendered our large towns possible and given a chance to millions of our workers of a wider outlook on life and the opportunity of living amongst healthier and more pleasant surroundings. This, as just stated, is not the result of a sudden discovery of some fundamental principle, but to a studied advance, step by step, from very elementary knowledge to the information we have available and at our disposal to-day.

Internal combustion engines.

The last method of propulsion that I can deal with is that by means of the internal combustion engine. This, as we almost universally have it to-day, is the result of the cycle adopted by N. A. Otto in his gas engine in 1876. Here, again, the engines we have to-day are the result of careful and studied investigation. It may be truly said that the advance made has been so much more rapid than in the case of the steam engine and electrical machinery because of the more advanced state of scientific knowledge, and it furnishes an example of the assistance which this gives to progress. In relation to transport, the work has proceeded on two distinct lines, the Daimler and the Diesel engines. In 1885, Gottlieb Daimler produced the engine that is associated with his name, and which utilises a light spirit which supplies a carburetted air for the explosive mixture for the cylinder. The development of this engine has itself proceeded in two directions. In the one, it has been made very much more flexible and silent in its adaptation to motor-car work; whilst, in the other, the great desideratum has been lightness and, in association with the improvements in the necessary materials, has rendered possible the aeroplane as we have it to-day. In both cases the development to the degree reached has been due to a careful study primarily of the pressures, compression and composition of the mixture. The Diesel engine was invented in 1894 by Rudolph Diesel, and consists of the injection of oil or pulverised fuel into the engine cylinder. Its development has taken place both on the four- and two-stroke cycle, and, although considerable progress had been made with land engines, it has chiefly been used for marine transport. The internal combustion engine has not been largely used for rail transport owing to its comparatively high cost of fuel per horse-power and its lack of flexibility. The latter is particularly the case when one remembers the high torque which is so desirable, and which can be attained in both the steam and electric locomotives in starting.

MISCELLANEOUS INFORMATION

[625 .143.2 & 62. (01]

1. — Standardisation of rail-testing methods.

(*The Railway Engineer.*)

In the perusal of some test results obtained recently on railway rails, rolled at different steelworks, but of the same section and to the same specification, we have been surprised to note the variation in average properties under test obtained on steels of approximately the same average chemical composition. To take one striking comparison, the basic open-hearth steel rails manufactured at one works, to an average carbon content of 0.60 %, and manganese content of 0.75 % (the principal factors in composition influencing test results, other than phosphorus, which was kept very low), showed an average deflection at the falling weight test, after the customary 7-foot and 20-foot blows of a ton tup on the 95-lb. British Standard section, of 2.87 inches, and an average ultimate tensile strength of 52.5 tons per square inch, with 13.9 % extension in 3 inches. At another works in the same neighbourhood, also manufacturing basic open-hearth steel, the rails, whose composition averaged 0.61 % carbon and 0.77 % manganese, deflected to an average of 3.14 inches and showed an ultimate tensile strength of 53.8 tons per square inch, with 14.6 % extension. That is to say, the steel which, on a composition basis, should have been the harder of the two, gave apparently the softer results under the falling weight test, although the tensile test fairly correctly expressed the difference in hardness, as judged by composition. In both cases the averages were obtained during lengthy contracts, and not fortuitous or haphazard selections.

Such comparisons suggest that, although tests themselves are standardised, there is still a good deal in connection with testing that might profitably become the subject of enquiry, with a view to standardisation, so far as standardisation is possible. As regards the falling weight test, there is a British Standard specification to be used in the construction of the machine itself, but this does little more than to lay down the depth and the nature of the foundations, the radius of surfaces of the bearings for the test-pieces and for the falling tup, and similar constructional details. It also adds the somewhat singular enactment that the weight shall not be pulled off by automatic means, although this is a considerably more accurate method of manipulation than pulling off by hand. But there are various minor matters, not covered in the specification which may appreciably affect the results obtained. The weight has necessarily to fall in guides, and the least tightness in these guides, or lack of lubrication, may suffice to reduce its momentum. If the test-piece be wedged on the supports, as is frequently done, in order to hold it upright and prevent it from twisting by receiving a glancing blow, it is possible to wedge it so tightly as to absorb a small proportion of the momentum of the weight in the friction of the rail in the bearers. It should not be a difficult matter to design some simple apparatus to measure the actual energy developed by the falling weight at the point of impact by the use of which the relative severity of different testing machines might be compared and checked.

Then again, there are various considerations in regard to the test-pieces themselves which are not covered in specifications. Of these one of the most important is the way in which the test lengths for the falling weight test have been cooled out. The finished rails themselves are run into tiers on the hot-bank, and by their immediate proximity to each

other cool out slowly. But the 5-foot test-pieces, cut off at the hot-saw, are nearly always cooled out separately, and consequently miss the slight annealing to which the rails themselves are subject as a result of the slow cooling. If check tests be broken from the finished rails, to compare with the original falling weight tests off the same casts, it is but seldom that the average results obtained on the finished rails will not be found slightly softer than the original tests. This could be overcome, of course, by compelling steel-makers, by specification, to cool out the test lengths on the top of the hot rails on the hot-bank, so that the former were subject to the same slight degree of annealing.

This difference is still more marked when the steelmaker works to the optional provision of the British Standard specification, as to making falling weight tests on top rail crops, instead of double-sawn pieces of rail from the centre of ingots. The top crop (however much its ability to withstand the test, representing as it does, the worst possible condition in the ingot, may be of value to the purchaser) is both liable to be carbonsegregated to at least some slight extent, and so to be harder as the rest of the rail, and also to be hardened to some extent by cold-rolling, by radiation, and by being the first portion of the ingot through the rolls at each alternate pass. We were shown recently a series of tests on a rolling of 95-lb. British Standard bull-head rails, which had been tested in the first instance on top-end crops, in which check tests broken from rails were an average of no less than 3/8 inch softer on the second deflection than the originals. Had the crops shown the maximum of permissible deflection of 4.1 inches (which was not the case), the real deflection for the casts concerned would have been round about 4.5 inches, and yet it would be a matter for considerable argument as to whether these casts could be rejected, seeing that a method of testing legalised by the specification had been followed, and the specification limit was not exceeded, even though the deflections did not accurately represent the test properties of the rails.

When we come to the tensile test, we are up against the same difficulties, although perhaps in a minor degree. It is a matter of common knowledge that tensile test results can be varied considerably according to the dexterity or otherwise with which the machine is manipulated. Variations in the rate of pulling, slight inaccuracies in the alignment of test-pieces in the test-machine, varied methods of turning and test-piece preparation — all have their vital influence on the results obtained, especially in the case of the exceedingly hard rail steels that are being manufactured at the present time. Consequently, while test limits are standardised, there seems room for a close investigation into the methods and the machinery by which the testing is conducted, in order that the tests obtained at different steelworks may be capable of comparison upon a precisely similar basis.

[621 .132.3 (.42) & 621 .134.1 (.42)]

2. — The first application of the « booster » in England.

As is well known, the *booster* is the American name for an auxiliary steam engine which serves to utilise the load on the trailing carrying wheels of a locomotive so as to increase the tractive effort at low speed. An article has already appeared in this *Bulletin* (1) on this device, which has since been applied to a considerable extent in America, especially on locomotives of the 4-6-2, 2-8-2 and 4-8-2 types.

In these engines, the trailing axle, which must be provided under the firebox in order to obtain a satisfactory distribution of load, cannot have wheels of the same diameter as the driving wheels on account of the width of

(1) See *Bulletin of the International Railway Association*, January 1921, p. 92.

the firebox. The adhesive weight is sufficient to transmit the power of the boiler at normal speeds, but when starting from rest or at low speed, there is a reserve capacity of steam production which is not utilised.

The *Railway Gazette* of the 27 July 1923 gives an account of the first application of the *booster* in England, or we may add in Europe, if we are dealing with the device in its present day form.

The engine in question is one of the *Atlantic* type on the London & North Eastern Railway constructed in 1910. Engines of this class have proved very satisfactory, but on account of the increase in the traffic and in the weights of the trains, their somewhat limited adhesive weight handicaps them in meeting traffic requirements. The same applies to *Atlantic* locomotives of other European railways, where these have had to be replaced by engines of the 4-6-0 or 4-6-2 types. It is hoped that by means of the *booster* the field in which these engines may be efficiently used may be considerably increased.

The principal dimensions of this engine are as follows:

Diameter of cylinders	20 inches.
Stroke of cylinders	24 —
Diameter of coupled wheels	6 ft. 8 in.
Heating surface, firebox	141 square feet.
— — small tubes	1 121 — —
— — large flue tubes	703 — —
— — total	2 533 — —
Superheater surface	568 square feet.
Working pressure	170 lb. per square inch.
Grate area	31 square feet.
Weight of engine in running order	74 tons 2 cwt.
Adhesive weight	20 tons.

Each of the pairs of driving wheels carry 20 tons, while the load on the trailing axle is 18 tons.

The tractive effort due to the ordinary cylinders, taking the mean pressure as being 85 % of the working pressure, is 17 340 lb. The auxiliary engine which has cylinders 10 × 12 inches produces an additional tractive effort of 8 500 lb., which corresponds to an increase of 50 %.

The auxiliary engine is fixed to the engine frame under the footplate and drives the trailing axle by means of a pinion and toothed wheel, the latter being keyed at the middle of the axle and does not gear with the pinion directly but through an idle wheel which is mounted on a movable shaft. The latter is controlled by a compressed air piston working in opposition to a spring. The admission of steam is controlled by an automatically operated regulator.

The operation of the *booster* is semi-automatic. A single movement on the part of the driver is sufficient to admit steam and to cause the movable gear wheel to engage.

It will be interesting to hear the results obtained by this application which should remedy one of the weak points of the *Atlantic* type as compared with other types of engines, while at the same time retaining their free running properties at high speeds.

E. M.

[385. 524]

3. — Bonuses given for economy in fuel and lubricants on the Czecho-Slovakian railways.

Mr. Kejr, engineer of the Czecho-Slovakian Railways, has sent us the text of the Ministerial instruction which came into force on the 1 July 1923 regarding the system of bonuses given to employees of the locomotive department for economy in fuel and lubricants

The following is a resume of the principal points.

Coal bonuses.

Basis on which bonuses are calculated. — The unit of work which is used as a base for calculating the bonuses is that necessary to haul 1 000 tonne-kilometres.

As this figure differs widely in accordance with the gradients of the line under consideration, the speed of the trains and the type of

engines, the actual tonne-kilometres are converted to standard tonne-kilometres by multiplying by a coefficient which has a definite value for each group of engines.

1 000 standard tonne-kilometres are defined as requiring the consumption of 100 kgr. (360 lb. per 1 000 English ton-miles), of average quality coal.

In order to determine the coefficient for converting the actual tonne-kilometres into standard tonne-kilometres for each group of engines, figures are based on the actual coal consumed during the summer season of 1922 and the winter season of 1922-1923. If for example it is found that for one particular group, that during the summer of 1922, a coal consumption of 160 kgr. per actual 1 000 tonne-kilometres (577 lb. per 1 000 English ton-miles) was recorded, the coefficient which must be applied for this group during the summer season is equal to $\frac{160}{100} = 1.6$.

Thus for each group of engines there are two coefficients, one for the summer period and one for the winter period. These coefficients remain unchanged unless modification in the rolling stock or in the types of engines make it necessary to determine fresh values.

Shunting engines. — The performance of shunting engines is also expressed in units of 1 000 standard tonne-kilometres. For this purpose the number of units of work corresponding to an hour of shunting is determined by dividing by 100 kgr. the hourly coal consumption for engines of the same type, either for the summer period of 1922, or, on the other hand, for the winter period of 1922-1923.

Calculation of bonuses. — In the first place the total economy of coal effected by a group of engines is determined by deducting the total amount of coal actually burned by the group of engines from the total allowance, which is obtained by multiplying the number of units at work (1 000 standard tonne-kilometres) by 100 kgr.

Only a part of the amount saved is paid as a bonus. The proportion paid to the staff decreases as the economy increases. This rule is justified in the circular, it being pointed out that it is the small economies which are the most difficult to effect, and that the greater economies are not as a rule due solely to the efforts of the staff, but are the result of circumstances which may be beyond their control.

By dividing the total saving for the group of engines by the work expressed in 1 000 tonne-kilometres, one obtains the saving per unit of work, and the portion which is given to the staff as a bonus is shown in the following table:

Saving in fuel per 1 000 equivalent tonne-kilometres, in kilograms (per 1 000 English ton-miles, in lb.).	Share given to footplate staff, per cent.	Saving in fuel per 1 000 equivalent tonne-kilometres, in kilograms (per 1 000 English ton-miles, in lb.).	Share given to footplate staff, per cent.
0.5 (1.80)	100	11 (39.60)	33
1 (3.60)	100	12 (43.20)	31
1.5 (5.40)	90	13 (46.80)	29
2 (7.20)	80	14 (50.40)	27
2.5 (9)	73	15 (54)	25
3 (10.80)	68	16 (57.60)	23
3.5 (12.60)	63	17 (61.20)	22
4 (14.40)	59	18 (64.80)	21
4.5 (16.20)	56	19 (68.40)	20
5 (18)	53	20 (72)	19
5.5 (19.80)	50	22 (79.20)	18
6 (21.60)	48	24 (86.40)	17
6.5 (23.40)	46	26 (93.60)	16
7 (25.20)	44	28 (100.80)	15
7.5 (27)	42	30 (108)	14
8 (28.80)	40	35 (126)	13
8.5 (30.60)	38	40 (144)	12
9 (32.40)	37	50 (180)	11
9.5 (34.20)	36	50 (180) and over	10
10 (36)	35		

The total bonus for the group is then calculated by reckoning the quantity of coal at one third of the market price, which is published by the Ministry of Railways for each period. For the period 1923, the price of a tonne of coal is 150 Czecho-Slovakian crowns.

The bonus is therefore 50 crowns per tonne of coal saved, reduced in accordance with the table given above.

Division of the bonuses. — The bonuses are calculated and divided monthly.

Drivers and firemen receive equal proportions. Where there are two firemen, each receives half of the fireman's portion.

The division of the total bonus for the group of engines is in proportion to the work done by each engine expressed in actual 1 000 tonne-kilometres.

BONUSES FOR ECONOMY IN THE USE OF LUBRICANTS.

The unit taken in this case is the engine-kilometre.

The allotted quantity per unit is the actual amount used for each group of engines during the summer period of 1922 and the winter period of 1922-1923.

The total amount allotted is the product of one or the other of these quantities multiplied by the number of engine-kilometres run by the group of engines during the month under consideration.

The economy gained, which is obtained by subtracting the actual amount used from the total quantity allotted, unlike the case of coal, is taken into account in its entirety in calculating the bonus, but only at one third of its price. For the period 1923, the price per kilogram (2.2 lb.) for the ordinary lubricant is 2.40 Czecho-Slovakian crowns, and the bonus per kilogram of lubricant saved is therefore 0.80 of a crown.

The bonus is divided up in each group of engines in proportion to the work done by each driver expressed in engine-kilometres.

It may be added that the supervisory staff and storekeepers are also interested in the economies effected in proportion to the bonuses paid.

In closing this article, we way make the following remark.

The total amount to be divided as a bonus being calculated for a group of engines, and the amount being divided in proportion to the amount of work done by the drivers, the amount which each man receives does not depend on the economy which he himself has effected, but is simply proportional to the 1 000 tonne-kilometres in the case of coal, and the engine-kilometres in the case of lubricants. The skill and care exercised by a driver results in increasing the total bonus for the group of engines, but only slightly benefits the individual and in an indirect manner.

According to information which we have received from the Czecho-Slovakian Ministry of Railways, the institution of direct bonuses dependent on the work done by each driver has met with opposition on the part of the staff, but the question is, however, still under consideration.

E. M.

[621 .33 (.42)]

4. — Financial prospects of electrification of railways in Great Britain [1].

Sir Philip Dawson, M. P., consulting electrical engineer to the Southern Railway, has recently read a paper before the Institute of Transport giving the results of an investigation, made under the instruction of the Minister of Transport, into the financial advantages that might be obtained by the extension of electrification on railways. The

(1) According to the report of Sir Philip Dawson : « On proposed substitution of electric for steam operation for suburban, local and main line passenger and freight services », published in London in 1921, and the *Railway Gazette* of 11 mai 1923 « The financial prospects of railway electrification ».

very thorough investigation was made in 1922, with the collaboration of the leading technical experts, relating to the results obtained in ten years working of the electrified lines on the Brighton Railway, as compared with working by steam. On account of the difference in the traffic carried, the lines were divided into two sections : 1° the suburban lines, running from the London Bridge and Victoria termini to Epsom, Coulsdon and Oxted; 2° the main lines running from Coulsdon to Worthing, Brighton, Seaford and Eastbourne. Every possible precaution was taken, moreover, to ensure, that comparison was only made between units of the same kind, with regard to traffic, receipts and expenditure.

Method of comparison. — Sir Philip Dawson commenced with the statement that, from the point of view of the last item, the « train-mile » is, in the case of passenger traffic, the unit which affords the truest basis for comparison, because, although the vehicle-mile or even this figure reduced to the seat-mile may at first sight appear to be more accurate criteria, it would lead to error if these were taken into consideration by themselves. It is also necessary to take account of the mean speed of the trains as will be seen by the following calculation : « Suburban passenger-trains consist on the average of 6.6 carriages capable of carrying 463 passengers and the electric trains average 4.4 carriages for 308 passengers; the main speed of these trains, steam driven, is 9.31 miles per hour, which gives $9.31 \times 463 = 4\,300$ seat-miles per hour, whereas the mean speed of electric trains is 21.8 miles per hour giving $21.8 \times 308 = 6\,714$ seat-miles per hour. Electric traction enables trains to be made up rapidly for the rush hours, whereas the steam trains run a large number of empty seats during the slack periods.

Financial advantages of electric traction. — With particular reference to financial results, the investigation first brought to light the fact that increase in working costs had taken place more rapidly with steam than with electric traction. From 1908 to 1921 the cost of working by steam had risen from 2 d. to 7.8 d. per carriage-mile, or by 290 %, whereas in the case of electric traction it had risen from 3 d. to 9 d. or 200 %. Per passenger-mile, for the same period, the cost of working had increased by 157 % (0.175 d. to 0.450 d.) for steam trains and by 108 % only (0.125 d. to 0.260 d.) for the electric trains. On the other hand the receipts had increased per electric carriage-mile by 228 % (6.5 d. to 21.3 d.), and per passenger-mile by 138 % (0.26 d. to 0.62 d.) whereas the respective increases for steam traction were only 126 % (7.3 d. to 16.5 d.) and 51 % (0.65 d. to 0.98 d.). Moreover, the mean number of passengers carried per steam train-mile was only about 7 in 1913, it reached the maximum of 12 in 1919 and fell to 10 in 1921; in the case of the electric trains the seating capacity had been much better utilized, the corresponding mean figures being 17.30 and 25 respectively.

The financial results obtained per mile of line worked are also in favour of electric traction, the gross receipts from which rose from £4 500 in 1913 to £11 300 in 1921,whereas the receipts per mile of line for suburban steam services which were £2 600 in 1913, amounted to only £3 200 in 1919 and fell to £2 800 in 1921. The comparison is still more striking if the net receipts for 1913, 1919 and 1921 are considered; these were £2 800, £5 000 and £6 500 respectively for the electric train service and £1 200, £2 100 and £660 for the steam service; in other words, the yield of the latter in 1921 was one-tenth of that obtained with electric working.

From all these figures it will clearly be seen that the receipts from the electrically worked lines have continued to grow while the expenses fell whereas the opposite was the case with the steam train service. The table here given, moreover, shows the increase in traffic and receipts of the lines which have been more particularly the subject of the investigation, and of which the electrification has cost £814 225.

—	Number of passengers carried.	Gross receipts, in pounds sterling.	Net receipts, in pounds sterling.
Last year of steam working	14 770 073	152 578	110 996
Electric working in 1919	34 896 090	418 201	236 205
— — in 1920	36 774 056	519 509	297 363
— — in 1921	31 088 860	526 471	305 392

It should here be mentioned also that, before electrification, the cost for steam traction per train-mile was 1 sh. 4 d. and that it rose to 4 sh. on the average in 1920, whereas it only amounted to 3 sh. 9 d. for electric traction.

Advantages of electric traction from the point of view of working. — With regard to the working of goods trains, shunting, marshalling, etc., Sir Philip Dawson stated that the advantages of electric traction were sufficiently well-known for it to be unnecessary to give them here in detail. It might however be of interest to state how greatly the capacity of terminal stations has been increased by the substitution of electricity for steam.

From the tables of actual traffic service it will be seen that the increase in transport capacity is :

220 % for the Victoria main line;
225 % for the Victoria suburban line;
142 % for the London Bridge main line;
206 % for the London Bridge suburban line.

It is, moreover, generally recognized, that electric traction gives particularly satisfactory results in working suburban lines with heavy traffic feeding large cities.

Forecast. — What financial advantages may be expected from the extension of the electrification of the suburban lines of the Brighton Railway as far as the coasts, the length of the electrified lines would then be as follows :

—	Lines already electrified or being electrified.	Electrification to complete the suburban lines.	Total suburban lines electrified.	Electrification of the main line to Brighton.
Miles of line	42	22	64	45
Miles of single track	123	70	193	121
Miles of sidings	12	107	119	56

The suburban system being supplied with high tension current at 11 000 volts, the extension of this to the main line will be relatively not costly. The close investigation into the complete electrification of the lines under consideration, taking account of all the expenses of transformation, equipment and rolling stock, has led to the conclusion:

1° That the cost of installation of the electrification of suburban lines will be in the ratio to that of the main line as 7 to 4;

2° That the total cost of working suburban lines will be in the ratio to that of the main line as 7 to 3;

3° That if the difference in increase of gross receipts resulting from the electrification of

the suburban lines and of the main line are in the ratio of 2 to 1, the ratio of the net receipts will be 7 to 6.

In making these calculations it has been assumed that the traffic carrying capacity has, as the result of electrification, been increased by 140 % on the suburban lines and 70 % on the main line. Taking into consideration, on the one hand, the costs of installation, as well as those of working, and, on the other hand, the traffic rates in force in 1922, an increase of 70 % of the gross receipts of suburban traffic and of 35 % for the main line, will be equivalent to a value of 8.5 % on the total capital necessary for the complete electrification of the system as proposed. Any further increase of 20 % in the gross receipts of the suburban section and of 10 % on the main line will represent an additional revenue of 3.5 % on the capital invested.

Conclusion. — The only remark made by Sir Philip Dawson in concluding, is that in order to obtain the greatest financial advantage, a complete scheme should be definitely decided from the beginning so that it may be carried out as economically as possible and may assure the maximum traffic-carrying capacity for the system.

Moreover, the time would appear to have come for the electrification of the main lines carrying heavy traffic. The following table shows what has been accomplished in this respect in the other principal countries :

—		Miles of track electrified.	Number of locomotives.
Single-phase current	Germany	800	288
	Austria	500	82
	Switzerland	660	175
	Sweden	280	47
	United States	700	130
Three-phase current	Italy	500	150
Direct current	France	500	138
	United States	1 400	220

[656. 253 (.73)]

5. — Results of an automatic train control test on the Pennsylvania Railroad.

(*Railway Review.*)

Results of tests of an automatic train control system, under practical operating conditions, which have been conducted for several weeks on the Lewistown branch of the Pennsylvania Railroad, between Lewistown Junction and Sunbury, Pa., were announced 1 August last by the train control committee of the Pennsylvania Railroad System, headed by A. H. Rudd, chief signal engineer. Results thus far obtained have been very encouraging and justify hopes that the system may provide a successful solution of the problem of preventing train collisions automatically, regardless of human failures.

Nearly a year was occupied in designing and trying out the necessary apparatus before the actual tests could begin. The system has been in operation throughout the entire Lewistown

branch since 11 July, and the movements of all trains, both freight and passenger, have been subject to its control. The entire trackage of the branch, which is approximately fifty miles in length, together with twelve locomotives, the entire number operated on the branch, have been equipped with the necessary electrical and other devices.

The purpose of the automatic train control system is to make impossible accidents caused by train collision, whether resulting from the imperfect reading of signals, from disregard of signals or other forms of human failure, or from failure of the signals themselves. This object is accomplished by a combination of electrical, pneumatic and mechanical devices applied both to the track and to the locomotives. These devices automatically slow down, or when required bring to a complete stop any train which approaches too closely to another on the same track, whether going in the same or opposite directions, or when switches are left open. Protective track sections of any length, suited to local operating conditions, may be established. In the case of the Lewistown branch the sections average about one mile in length.

The first step in establishing the system was to equip the track so as to enable it to carry an alternating current. The appliances and devices for the purposes are practically the same as those used in the existing visual block signal systems.

Every engine is equipped with electrical apparatus which, without actually touching the rail, picks up the current from the track by induction. This current, after being « stepped up » to a sufficient power, performs two functions. One is to operate the cab signals, which are three in number. The other is to operate the air brakes if another train is approached too closely, or proper rates of speed are exceeded, or in the event of an open switch. These functions are performed without any action being required on the part of the engineer or fireman.

Inside the engineer's cab are his signals, three electric bulbs which keep him constantly informed of the conditions ahead. One of these bulbs is marked « A ». When it is lighted the engineer knows that he has a clear track for at least two full sections ahead. He is then free to run his train at any speed up to the maximum allowed for his division. He cannot exceed this maximum speed, however, because if he attempts to do so the air brakes will be automatically applied. Hence the maximum speed rule cannot be broken even if an engineer should attempt to do so.

The next light is marked « R ». When it burns the engineer knows that he has one clear section ahead, but that there is another train or open switch somewhere in the second section ahead. This light is the signal for medium speed, and while it burns the automatic mechanism holds down the velocity of the train to whatever limit is fixed as « medium speed » on the division in question — for instance, thirty miles per hour. This speed the engineer cannot exceed even should he so attempt, as the brakes will be applied.

The third bulb is marked by the letter « S » and is a « slow » or « stop » signal as conditions require. The indication from this signal is given at a point about 1 800 feet before the train reaches a section occupied by another train or having an open switch. If this light burns, and the engineer takes no action, the train control devices will apply the air brakes and bring the train to a complete stop. If, however, the engineer « acknowledges » the signal, by throwing a lever provided for that purpose, he can proceed at « slow speed » with his train under perfect control. The limit of « slow speed », as in the case of « high » and « medium », is fixed at different rates for different divisions, but when the « slow » signal burns, the speed determined for that particular division cannot be exceeded.

The outstanding advantages of automatic train control system are two in number:

1° It keeps the engineer in continuous touch with conditions ahead, as he carries the signals with him in the engine cab. With visual signals, on the right of way, the engineer is in touch with conditions ahead only when passing the signals, which may be one to five miles apart;

2° It « plays safe » in the event of man-failure and brings the train safely to a stop, even should the engineer completely fail to do his part. In the event of sickness, injury or death of the engineer, it brings the train safely to a stop.

In addition, it is hoped that under automatic control it will be found possible to operate over a given stretch of track, without danger or interference, more trains than can be handled with the existing forms of dispatching or signalling. This however remains to be demonstrated.

A final provision for insuring safety lies in the fact that should the train control system itself become deranged, as for instance through the failure of the track circuit, the effect will be to bring to an immediate stop all trains on the portion of the track involved.

The Lewistown branch, on which the tests are being made, is chiefly single track. The automatic train control on this branch is supplemented by visual signals at intervals of five miles. The purpose of these signals is not so much to guard against collision as it is to keep opposing trains from going past points at which sidings exist for passing purposes; also, to provide means for delivering orders in case of necessity.

NEW BOOKS AND PUBLICATIONS

[385. (02 & 385. (04]

TAJANI (Filippo), engineer, professor at the Royal Polytechnic College, Milan. — **Trattato moderno di materiale mobile ed esercizio delle ferrovie (Treatise on modern rolling stock and the working of railways).** — Volume II : Esercizio tecnico. — Impianto delle stazioni (Technical operation. — Lay-out of stations). — In-8vo (10 × 7 inches), of XII + 388 pages, with 8 plates and 393 figures in the text. — 1924, Milan, Libreria editrice politecnica di Cesare Tamburini fu Camillo, Piazza Cavour, 2. — Price : 54 lires.

The second volume of the *Treatise on the operation of railways* by Mr. F. Tajani, professor of the Royal Polytechnic College at Milan, is divided into two parts : the first deals with technical operation, and the second with the lay-out of stations.

Technical operation is again divided into two sections dealing respectively with the movement of trains and rolling stock and with signalling.

The section relating to operation of trains is sub-divided into four chapters :

The first of these relates to the make up of the trains from the point of view of load, weight and maximum length, of the order in which they are made up, and of regulations relating to braking by hand or by continuous brake.

The second chapter deals with time tables and the speed of trains; it shows how the time tables may be laid out graphically and also how one can show graphically whether the roads in a station are free or not so as to arrange for the time of the services.

The third chapter comprises matters on the running of the trains, and the block system and methods of « train despatching » to regulate the running of trains are explained.

The fourth chapter deals with the circulation of wagons and the working of goods traffic.

The second section, which treats with signalling, is divided into five chapters:

The first chapter is on the shape, position and working of signals. It is sub-divided into paragraphs which deal with protecting signals, warning signals, three-position signals, signals which are repeated by fog signals, bells, etc., the working and control of signals, switch signals and shunting signals.

The second chapter deals with the interlocking of the points and signals.

The third gives a description of the various methods of working the points and signals, and especially mechanical appliances and those worked hydraulically, electric pneumatically and electrically.

The end of this very interesting chapter deals with the mechanism of interlocking.

The fourth chapter deals with the methods of locking with single ground and multiple levers, control and distant levers, and gives examples of signal boxes for the protecting of a junction and a station.

The fifth chapter describes the block system, the systems of Cardani-Servettaz, Siemens and Halske, the automatic block, the staff system and their application.

The second part of this second volume (the fourth portion of the complete

treatise) deals with the lay-out of stations. It is divided up into six chapters, the first five of which deal with small stations, medium size stations, junction stations, large stations and maritime stations.

The sixth chapter describes the various necessary and accessory arrangements at a station, such as the water supply, water cranes, coal stages and locomotive sheds.

Written in a very clear and concise manner, and illustrated by numerous and clear diagrams, which allow the working of the various appliances and the signalling arrangements and lay-outs to be seen at a glance, the second volume does great credit to Mr. Tajani. The praise which we gave to the first volume (1) of the work applies equally to the clear, detailed, and at the same time, instructive volume which we are now dealing with.

J. V.

[625 .1 (.02 & 385 (.04]

WEBB (W. L.), civil engineer. — **Railroad construction.** — Theory and practice. A text-book for the use of students in colleges and technical schools and a text-book for the use of engineers in field and office. — 7th edition, revised and enlarged. — One volume in 16vo (4 1/2 by 6 3/4 inches) of XVII + 847 pages, 225 figures and 10 plates. — 1922, John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London. — Price : $5 net.

This book deals with the various questions which arise in the construction of railways and of the buildings and works which are necessary in working the same.

Written as a text book and as a reference for the professional engineer, it gives in a concise form rules to be followed, recommendations to be observed, the principles to be applied and the ordinary methods of calculation. It gives a full description of the various materials employed and as regards structures above the level of the ground, the general arrangements which appear to best meet practical requirements.

In addition to the author's own practical and theoretical experience, information is borrowed from the work of various authorities, especially those of the American Railway Engineering Association, which, as is well known, is based on most careful research, so that it may be considered that this book, which is in its 7th edition, gives a full account of the present day condition of railway constructional science in the United States.

In order to analyse this book, it may be divided up into two parts, of which the former deals directly with the construction of the line. The author deals successively with the survey work and investigations to be carried out in order to determine the general location, the geometrical methods used in order to lay out curves, and the relation of straight portions of the line and the curves connecting the same. The chapters dealing with the construction of the formation include calculations for the amount of earth work, driving of tunnels, timber constructions, aqueducts, culverts, etc. Then follows the construction of the track, including a discussion on ballast, sleepers, rails and their fastenings, platelayers tools and a geometrical lay-out of points and crossings. A chapter deals with the principles to be followed in establishing a water supply, station buildings and platforms, goods warehouses, engine sheds and their adjuncts; while another

(1) See the *Bulletin of the International Railway Association*, for December 1921, p. 2268.

deals with the lay-out of stations. This portion terminates by a discussion on the various systems of block signalling.

The engineer who constructs a railway ought also to consider certain questions from a motive power and traffic standpoint, which have a bearing on the lay-out and gradients of the line, and which are the ruling factors in fixing the maximum gradients and the minimum radius of curves. The technical conditions which are decided upon before building a line depend largely on its financial prospects. These remarks justify the utility of the second portion of the book, in which an analysis is made of the various circumstances which may influence the balance sheet of receipts and expenses.

This latter portion starts by setting forth some essential conceptions on the rolling stock and its relation to the track. Then follows a discussion on resistance of trains, the estimation of the expenses of constructing the line and the performance and running expenses of locomotives, the influence of gradients and curves on the traffic organisation and the expenses which result from the same, the estimation of traffic expenses and their classification, the influence of the length of haul on the expenses and rates and the improvement of existing lines.

The last chapter gives an account of the results obtained by various trials and researches undertaken conjointly by the American Railway Engineering Association and the American Society of Civil Engineers to determine the stresses imposed by rolling loads on the various elements which constitute the track.

The practical value of the work is increased by the addition at the end of the book of numerous tables, especially those giving all the necessary information for laying out curves and points and crossings.

E. M.

[385. (02 & 385. (04]

BORDAS (L.), government inspector of railways. — **Leçons sur les chemins de fer** (degré moyen) [**Lectures on railways** (intermediate stage)]. — One volume in 16mo (7 × 4 1/2 inches) of XVI + 494 pages, with 157 figures in the text and on plates. — 1922, Gaston Doin, editor, 8, place de l'Odéon, Paris. — Price : 15 francs.

Mr. Bordas' book has for its object the popularisation of the technique and operating methods of railways, not only from the point of view of operation, but also with matters which concern the employees.

It consists of 21 lectures on the following subjects :

The history and formation of the French Railways .	2 lectures.
Legal regulations of railways.	2 —
Matters dealing with the permanent way and rolling stock	8 —
Technical operation (trains, signals and accidents) . .	3 —
Commercial operation (rates and traffic agreements) .	4 lectures.
Organisation of the staff . .	2 —

This elementary treatise for the intermediate stage has been published at the time when all railway administrations are concerned with the technical education of their employees, whatever position they occupy on the staff.

It allows of each person to obtain a general idea of the organisation of railways as a whole, and makes them better able to take up the special study of the particular branch they are employed in.

J. V.

[625 .3 (09.3 (.494) & 385. (04]

STOCKMAR (J.), late president of the 1st division of the Swiss Federal Railways. — **Histoire du chemin de fer du Simplon (History of the Simplon Railway).** — One volume in 8vo (9 × 6 inches), of 140 pages. — 1920, Payot & Co., 1, rue de Bourg, Lausanne, and 2, place du Molard. Geneva. — Price : 6 francs.

The *History of the Simplon Railway* drawn up by the late Joseph Stockmar, president of the 1st division of the Swiss Federal Railways, is a posthumous work. He was engaged in finishing this interesting monograph when he died suddenly in July 1919. It was as a tribute to his memory that his friends immediately decided on the publication of this work.

Written in a clear and concise manner, the history of the Simplon confines itself only to the historical and financial side of the work from the first establishment of railways in Switzerland (1850) until the present time. It deals with the agreements and political arrangements, financial and otherwise, of the first twenty years, and of the trouble between the Council of the Canton of Valais, and an adventurer named La Valette. The reports of the experts, who came to the conclusion that it was impossible to construct a railway through the Alps, is dealt with, and finally of the part played by the taking over of the railways by the Federal Government which led to the satisfactory carrying out of the work.

An important chapter of the book (so full of information) by Mr. Stockmar, deals with the lines connecting up to the Simplon, which allows him to give a true and special account of the Lötschberg line which forms the chief connection.

As regards the future of the Simplon Railway, it is no use, says the Author, in finishing the preface, to attempt to conjecture what will be the effects of the new economical arrangements, affecting as they do the commercial agreements and arrangements. It does not, however, seem that the Simplon will suffer.

J. V.

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PUBLISHED UNDER THE SUPERVISION OF

J. VERDEYEN,

General secretary of the Permanent Commission of the International Railway Congress Association.

[016 .385. (02]

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[1] The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science," by L. WEISSENBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1509.)

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Engineering, No. 2977, January 19, p. 67.
ROBSON (T.). — Determination of the **fatigue-resisting capacity of steel** under alternating stress. (1 800 words & fig.)

1923 625 .1
Engineering, No. 2977, January 19, p. 73.
STRINGER (H.). — **Railway economics** for extra-European railways. (1 500 words & 1 table.)

1923 721 .9 (.51)
Engineering, No. 2977, January 19, p. 73.
STRINGER (H.). — **Reinforced concrete** on the Chinese Railways. (900 words.)

Engineering News-Record. (New York.)

1922 625 .113
Engineering News-Record, No. 19, November 9, p. 804.
ARMSTRONG (W. W.). — Locating a **curve** with an inaccessible P. I. in Thorn- brush country. (150 words & fig.)

1922 624 .63 (.73)
Engineering News-Record, No. 21, November 23, p. 870.
SLACK (S. B.). — Building **concrete bridge** around an old steel bridge. (2 200 words & fig.)

1922 621 .31 (.481)
Engineering News-Record, No. 21, November 23, p. 873.
LLOYD (W. F.). — A low-head **hydro-electric plant** of 84 000 H. P. in Norway. (1 300 words & fig.)

1922 625 .13 (.73)
Engineering News-Record, No. 21, November 23, p. 877.
Foundation excavation removed by **tunnels** at Chicago. (800 words & fig.)

1922 625 .3 (.73)
Engineering News-Record, No. 21, November 23, p. 879.
Logging railway practice in the Northwestern forests. (2 800 words & fig.)

1922 625 .12 (.73)
Engineering News-Record, No. 21, November 23, p. 884.
Bridge protected from shifting channel : B. & O. R. R. (1 000 words & fig.)

1922 725 .33 (.73)
Engineering News-Record, No. 22, November 30, p. 916.
Building the Baldwin **reservoir**, Cleveland waterworks. (2 700 words & fig.)

1922 691 (.73)
Engineering News-Record, No. 23, December 7, p. 962.
Construction methods and plant on the Marseilles lock. (2 400 words & fig.)

1922 691
Engineering News-Record, No. 23, December 7, p. 968.
Protecting **steel bridges** from locomotive blast. (1 000 words & fig.)

1922 625 .13 (.73)
Engineering News-Record, No. 23, December 7, p. 973.
Steel and wrought-iron trusses efficiently combined in railway **bridge reconstruction**. (3 800 words & fig.)

1922 624 .63 (.728)
Engineering News-Record, No. 23, December 7, p. 981.
Porto Rican concrete **arch bridge** has novel spandrels. (300 words & fig.)

1922 624 .1 (01 (.73)
Engineering News-Record, No. 23, December 7, p. 986.
Wide-web column tests for Delaware river bridge. (800 words & fig.)

1922 625 .1 (.73)
Engineering News-Record, No. 24, December 14, p. 1014.
Building the North Platte Branch; Union Pacific R. R. (800 words & fig.)

1922 625 .13 (.73)
Engineering News-Record, No. 24, December 14, p. 1021.
BURR (Col. E.). — Remove subaqueous ledge above **rapid transit tunnel**. (3 000 words & fig.)

1922 625 .123 (.73)
Engineering News-Record, No. 24, December 14, p. 1026.
WILBANKS (J. R.). — Changes in Mattamuskeet **drainage** district, North Carolina. (1 500 words & fig.)

1922 624 .63
Engineering News-Record, No. 24, December 14, p. 1029.
Concrete bridge a continuous beam on hinged piers. (600 words & fig.)

1922 625 .111
Engineering News-Record, No. 24, December 14, p. 1032.
MOLTHER (F. R.). — **Plotting transit lines** by natural tangents and cotangents. (1 200 words & fig.)

1922 625 .13 (.73)
Engineering News-Record, No. 24, December 14, p. 1034.
GODFREY (E.). — **High viaduct** moved 75 feet laterally. (1 200 words & fig.)

1922 625 .13 (.73)
Engineering News-Record, No. 24, December 14, p. 1042.
Launch caisson for N. Y. vehicle tunnel shaft. (1 000 words & fig.)

1922 624 .63 (.73)
Engineering News-Record, No. 25, December 21, p. 1056.
Track elevation on long **concrete viaduct** at Aurora, Ill. (2 700 words & fig.)

1922 625 .111 (.497.1)
Engineering News-Record, No. 25, December 21, p. 1070.
ATWOOD (Col. W. G.). — **Jugo-Slavia plans railroads** to open up resources. (1 800 words & fig.)

1922 624 .92 (.73)
Engineering News-Record, No. 26, December 28, p. 1110.
Heavy **trestlework** required on new logging railroad. (1 000 words & fig.)

1922 721 .9 (.73)
Engineering News-Record, No. 26, December 28, p. 1119.
Small **tunnels** lined with precast **concrete ribs**. (500 words & fig.)

Journal of the Franklin Institute. (Philadelphia.)

1922 62. (01
Journal Franklin Institute, No. 6, December, p. 713.
TROWBRIDGE (A.). — High-speed **photography of vibrations** (sound, mechanical, electrical, etc.) (5 300 words & fig.)

1923 621 .3
Journal Franklin Institute, No. 1, January, p. 45.
COHEN (L.). — **Electrical oscillations** on lines. (3 400 words.)

Journal of the Institute of transport. (London.)

1922 313 .385. (01 (.42)
Journal of the Institute of transport, No. 2, Dec., p. 48.
ACWORTH (Sir W.). — British railway **operating statistics** and their lessons. (15 000 words.)

Journal of the Western Society of Engineers. (Chicago.)

1922 656 .253
Journal Western Society of Engin., No. 12, Dec., p. 362.
ECK (W. J.). — Development and installations of **automatic train control**. (5 300 words.)

1922 656 .253
Journal Western Society of Engin., No. 12, Dec., p. 370.
STEVENS (Thos. S.). — **Automatic train control** (from a signal standpoint). (2 800 words.)

1922 656 .253
Journal Western Society of Engin., No. 12, Dec., p. 374.
GILES (C. F.). — **Automatic train control** (from a mechanical standpoint). (1 900 words.)

1922 656 .253
Journal Western Society of Engin., No. 12, Dec., p. 377.
TOWSLEY (A. W.). — **Automatic train control** (from a transportation standpoint). (4 000 words.)

Locomotive, Railway, Carriage and Wagon Review. (London.)

1922 621 .131.2 (.944)
Loc. Ry. Carr. & Wag. Review, No. 364, Dec. 15, p. 351.
LUCY (E. E.). — Recent and future **locomotive design** in New South Wales. (4 500 words & fig.)

1923 621 .132.6 (.42)
Loc. Ry. Carr. & Wag. Review, No. 365, Jan. 15, p. 1.
Four-cylinder **tank locomotive**, North Staffordshire Ry. (1 500 words & fig.)

1923 621 .132.3 (.493)
Loc. Ry. Carr. & Wag. Review, No. 365, January,15, p. 5.
New **compound locomotives**, type 8*bis*, Belgian State Rys. (2 000 words & fig.)

Mechanical Engineering. (New York.)

1922 621 .134.2
Mechanical Engineering, No. 12, December, p. 801.
HARTMAN (G. H.). — **Steam distribution** in the locomotive. (5 700 words & fig.)

1922 625 .13 (.73)
Mechanical Engineering, No. 12, December, p. 826.
Research fundamental for Hudson tunnel design. (2 900 words & fig.)

Proceedings, American Society of Civil Engineers. (New York.)

1922 385. (09.1
Proceed. Amer. Soc. Civil Eng., No. 10, Dec., p. 1824.
MATTHES (G. H.). — **Aerial photography** as an aid in map making, with special reference to water power surveys. (9 500 words, 1 table & fig.)

1922 621 .31 (.73)
Proceed. Amer. Soc. Civil Eng., No. 10, Dec., p. 1846.
GALLOWAY (J. D.). — **Hydro-electric developments** on the Pacific coast. (5 300 words, 10 tables & fig.)

1922 621 .31 (.73)
Proceed. Amer. Soc. Civil Eng., No. 10, Dec., p. 1865.
DENNIS (H. W.) & BARRE (H. A.). — Growth of the use of **electric power** in Southern California and probabilities of its future growth with reference to sources of hydraulic power.(2 400 words, 5 tables & fig.)

1922 621 .331
Proceed. Amer. Soc. Civil Eng., No. 10, Dec., p. 1872.
LOWETH (C. F.). — **Hydro-electric power** development as related to the electrification of railroads. (3 800 words.)

1922 624. (01
Proceed. Amer. Soc. Civil Eng., No. 10, Dec., p. 1901.
Locomotive loadings for **railway bridges**.(3 000 words.)

Proceedings, Institution of Civil Engineers. (London.)

1922 625 .112 (.54)
Proceed. Institut. of Civil Eng., vol. CCXIII, nov., p. 15.
ROYAL-DAWSON (F. G.). — The Indian railway **gauge problem**. (50 000 words, 15 tables & fig.)

1922 625 .251
Proceed. Institut. of Civil Eng., vol. CCXIII, Nov., p. 208.
RENDELL (A. W.). — **Control of trains**, in relation to increased weight and speed combined with reduced headway. (5 400 words & fig.)

1922 625 .25
Proceed. Institut. of Civil Eng., vol. CCXIII, Nov., p. 22
FOWLER (Sir Henry) & GRESLEY (H. N.). — Tria in connection with the application of **the vacuum-brak** for long freight-trains. (24 000 words, 2 tables & fig.)

1922 62. (0
Proceed. Institut. of Civil Eng., vol. CCXIII, Nov., p. 35
LAWS (B. C.). — Distribution **of stress in thin mild steel plates** of rectangular shape, fixed along thei edges, and subject to uniformly-distributed loads. (9 50 words, tables & fig.)

1922 721 .
Proceed. Institut. of Civil Eng., vol. CCXIII, Nov., p. 38
COWLING (H. W.). — A spiral staircase constructe in **reinforced-concrete**. (1 400 words & fig.)

1922 625 .11
Proceed. Institut. of Civil Eng., vol. CCXIII, Nov., p. 39
ROBINSON (R. B.). — A method of introducing **tran sition curves**. (600 words, 2 tables & fig.

Proceedings, Institution of Mechanical Engineers (London.)

1922 621 .33
Proceed. Institut. of Mechan. Eng., No. 5, Nov., p. 1057
Discussion on **electric locomotives**, friday, 17th No vember 1922. (13 800 words.)

Railway Age. (New York.)

1922 656 .25
Railway Age, No. 20, November 11, p. 896.
HOLT (T.). — **Signaling** busy terminals. (800 word & fig.)

1922 621 .7 (.73)
Railway Age, No. 22, November, 25, p. 973.
Schedule assists in rapid **shop reorganization**. (2 70 words & fig.)

1922 656 .261
Railway Age, No. 22, November 25, p. 991.
LYFORD (W. H.). — Competition or co-operation **with motor truck**. (4900 words.)

1922 621 .132.8 (.73)
Railway Age, No. 22, November 25, p. 1012.
Light weight **gasoline car** for heavy grade line. (300 words & fig.)

1922 621 .33 (.73)
Railway Age, No. 22, November 25, p. 1013.
SMITH (H. K.). — Some service records of **electric equipment**. (2 000 words & fig.)

1922 624 .63 (.73)
Railway Age, No. 23, December 2, p. 1035.
HITCHCOCK (Ch. H.). — Philadelphia & Reading builds 46- **arch bridge**. (1 900 words & fig.)

1922 621 .134.2
Railway Age, No. 23, December 2, p. 1051.
All-service **locomotive power reverse gear**. (900 words & fig.)

1922 656 .253

Railway Age, No. 24, December 9, p. 1085.

Road test of Clifford **automatic train control.** (1 400 words.)

1922 621 .133.5

Railway Age, No. 24, December 9, p. 1099.

COPPUS (F. H. C.). — The mechanical **drafting of locomotives.** (3 900 words & fig.)

1922 625 .17 (.73)

Railway Age, No. 25, December 16, p. 1123.

Illinois Central improves line near Chicago. (3 500 words & fig.)

1922 656 .222.1

Railway Age, No. 25, December 16, p. 1145.

Effect on **ton-mile cost** of reducing train loads. (3 500 words, 3 tables & fig.)

1922 625 .142.2 (.73)

Railway Age, No. 26, December 23, p. 1177.

Treating plant solves New Haven's **tie problem.** (2 300 words & fig.)

1922 656 .253 (.73)

Railway Age, No. 26, December 23, p. 1185.

Traffic direction by **signal indication** on D. L. & W. (3 500 words & fig.)

1922 621 .132.5 (.73)

Railway Age, No. 26, December 23, p. 1197.

Powerful **consolidation locomotive** for the L. & N. E. (700 words, 1 table & fig.)

1922 656 .223.2 (.73)

Railway Age, No. 27, December 30, p. 1229.

HALLIHAN (J. P.). — The distribution of railway **freight car ownership.** (2 600 words & tables.)

1922 625 .112 (.3)

Railway Age, No. 27, December 30, p. 1234.

Many **gages** are found throughout the world. (900 words & tables.)

Railway Engineer. (London.)

1922 625 .232

Railway Engineer, No. 515, December, p. 445.

New **rolling-stock** for the International Sleeping Car Company. (3 400 words & fig.)

1922 625 .151

Railway Engineer, No. 515, December, p. 454.

WALKER (R. D.). — A practical chart for **point and crossing work.** (3 300 words & fig.)

1922 621 .335 (.42)

Railway Engineer, No. 515, December, p. 457.

Electric locomotives on the Metropolitan Railway. (3 300 words & fig.)

1922 621 .133.3

Railway Engineer, No. 515, December, p. 463.

WRENCH (A.). — Methods of fitting locomotive **boiler tubes.** (1 500 words & fig.)

1922 656 .253 (.493)

Railway Engineer, No. 515, December, p. 465.

Weissenbruch's **signal system** on the Belgian State Railways. (700 words & fig.)

1922 624. (01

Railway Engineer, No. 515, December, p. 467.

The Suldbach **bridge tests.** (4 000 words & fig.)

1923 656 .256 (.42)

Railway Engineer, No. 516, January, p. 5.

Intermediate **block signalling.** (2 100 words.)

1923 625 .143.2

Railway Engineer, No. 516, January, p. 7.

ALLEN (C. J.). — The « neutral » steel process in **rail manufacture.** (2 800 words, 1 table & fig.)

1923 625 .212

Railway Engineer, No. 516, January, p 10.

Roller bearings for railway vehicles. (1 000 words & fig.)

1923 621 .132.3 (.42)

Railway Engineer, No. 516, January, p. 13.

New three-cylinder **express locomotive,** North Eastern Railway. (500 words & fig.)

1923 656 .253 (.945) & 656 .255 (.945)

Railway Engineer, No. 516, January, p. 14.

Automatic signals on single lines, Victorian Government Railways. (2 800 words & fig.)

1923 621 .335 (.494)

Railway Engineer, No. 516, January, p. 18.

Single-phase **electric locomotive** with individual axle drive. (1 600 words & fig.)

Railway Gazette & News. (London.)

1922 625 .13 (.54)

Railway Gazette & News, No. 23, December 8, p. 748.

Girder renewals on the South Indian Railway. (1 000 words & fig.)

1922 621 .132.3 (.42)

Railway Gazette & News, No. 23, December 8, p. 751.

New 3-cylinder « Pacific » type **express locomotive,** North Eastern Railway. (400 words & fig.)

1922 621 .87 (.6)

Railway Gazette & News, No. 23, December 8, p. 753.

High-capacity steam **breakdown cranes.** (1 800 words & fig.)

1922 625 .232 (.44)

Railway Gazette & News, No. 24, December 15, p. 783.

New **sleeping cars,** Calais-Mediterranean express. (2 200 words & fig.)

1922 656 .253 (.945) & 656 .255 (.945)

Railway Gazette & News, No. 24, December 15, p. 789.

Protecting single lines by **automatic signals.** (800 words & fig.)

1922 621 .132.1 (.489)
Railway Gazette & News, No. 25, December 22, p. 820.
Modern **locomotives** of the Danish State Railways. (1 900 words & fig.)

1922 625 .18 (.73) & 625 .245 (.73)
Railway Gazette & News, No. 25, December 22, p. 823.
BRENNAN (Th. J.). — **Supply train** operation on a great American railway. (1 800 words & fig.)

1922 621 .132.6 (.42)
Railway Gazette & News, No. 25, December 22, p. 831.
New 4-cylinder **tank engine**, North Staffordshire Railway. (400 words & fig.)

1922 385 .4 (.945)
Railway Gazette & News, No. 26, December 29, p. 860.
The **signal** and **telegraph branch**, Victorian Government Railways. (1 100 words & fig.)

1922 656 .212 (.42)
Railway Gazette & News, No. 26, December 29, p. 862.
Goods station working on the Midlard Railway. (7 800 words & fig.)

1922 621 .132.8 (.44)
Railway Gazette & News, No. 26, December 29, p. 876.
Experimental **motor train** in France. (400 words & fig.)

1923 621 .132.1 (.42)
Railway Gazette & News, No. 1, January 5, p. 4.
British locomotives in 1922. (1 000 words.)

1923 656 .211 (.42)
Railway Gazette & News, No. 1, January 5, p. 13.
Some **Caledonian station** and their **traffic**. (2 600 words & fig.)

1923 624 .8 (.42)
Railway Gazette & News, No. 1, January 5, p. 20.
The King's **ferry bridge** over the Swale. (500 words & fig.)

1923 385 .113 (.82)
Railway Gazette & News, No. 1, January 5, p 23.
Argentine railways in 1921-22. (4 300 words & tables.)

1923 621 .132.6 (.43)
Railway Gazette & News, No. 2, January 12, p. 49.
Heavy **tank locomotives** for service in Germany. (500 words & fig.)

1923 625 .4 (09.3 (.42)
Railway Gazette & News, No. 2, January 12, p. 58.
Diamond jubilee of the **Metropolitan Railway**. (2 000 words & fig.)

Railway and Locomotive Engineering. (New York.)

1922 625 .245 (.73)
Railway and Locomotive Engin., No. 12, Dec., p. 315.
Container car freight service on the New York Central. (1 400 words & fig.)

1922 656 .222.1
Railway and Locomotive Engin., No. 12, Dec., p. 317.
The cost of **stopping a freight train**. (2 400 words & 1 table.)

1922 385 .1 (.7
Railway and Locomotive Engin., No. 12, Dec., p. 321.
MARKHAM (Ch. H.). — The general **railway situ**tion. (3 800 words.)

1922 621 .132.3 (.7
Railway and Locomotive Engin., No. 12, Dec., p. 323.
Most powerful **passenger locomotive** in the worl (1 700 words & fig.)

1922 621 .132.3 (.7
Railway and Locomotive Engin., No. 12, Dec., p. 329.
Pacific type **locomotive** for the Atlantic Coast Lin (800 words & fig.)

1922 625 .216 (.5
Railway and Locomotive Engin., No. 12. Dec., p. 340.
Mechanical couplers on the railways of India. (9 words & fig.)

Railway Magazine. (London.)

1922 385. (09.1 (.5
Railway Magazine, No. 306, December, p. 409.
SULLOCK (B. D.). — The Bombay **suburban servic** of the Great Indian Peninsula Railway. (1 600 wor & fig.)

1922 385. (09.3 (.4
Railway Magazine, No. 306, December, p. 415.
JOHNSON (H. B.). — An **Elizabethan railway.** (3 4 words.)

1922 385. (09.1 (.4
Railway Magazine, No. 306, December, p. 420.
AHRONS (E. L.). — Locomotive and train worki in the latter part of the 19[th] century. **The Marypo and Carlisle Railway.** (2 300 words & fig.)

Railway Maintenance Engineer. (Chicago.)

1922 691 & 721
Railway Maintenance Engineer, No. 12, Dec., p. 414.
TOMLINSON (D. A.). — Promoting the art making **good concrete.** (3 000 words & fig.)

1922 624 .8 (.7
Railway Maintenance Engineer, No. 12, Dec., p. 421.
Canadian national builds an ingenious **lift brid** (1 200 words & fig.)

Railway Mechanical Engineer. (New York.)

1922 621 .131.2 (.4
Railway Mechanical Engineer, No. 12, December, p. 6
POULTNEY (E. C.). — Recent tendencies in Briti **locomotive practice.** (5 000 words & fig.)

1922 5
Railway Mechanical Engineer, No. 12, December, p. 6
LESSELLS (J. M.). — Some **properties of materi** and their use. (1 400 words & fig.)

1922 625 .245 (.7
Railway Mechanical Engineer, No. 12, December, p. 6
GALLAGHER (F. S.). — Recent developments in u **of container cars.** (1 700 words & fig.)

1922 625 .216
Railway Mechanical Engineer, No. 12, December, p. 695.
MEYER (W. J.). — Protecting draft gear from solid impact. (1 200 words & fig.)

1922 621 .132.8 (.73)
Railway Mechanical Engineer, No. 12, December, p. 697.
Motor driven rail car with high power unit. (1 000 words & fig.)

1922 625 .232 (.73)
Railway Mechanical Engineer, No. 12, December, p. 699.
Pennsylvania System dining cars built at Altoona. (1 500 words & fig.)

1922 725 .33 (.73)
Railway Mechanical Engineer, No. 12, December, p. 719.
Erie builds new enginehouse at Jersey City, N. Y. (2 200 words & fig.)

Railway Review. (Chicago.)

1922 621 .135.2
Railway Review, No. 20, November 11, p. 654.
Flange oilers reduce rail and tire wear. (1 600 words & fig.)

1922 656 .222.6 (.73)
Railway Review, No. 21, November 18, p. 693.
Freight train classification on the Baltimore & Ohio. (1 000 words & fig.)

1922 656 .223.2 (.73)
Railway Review, No. 21, November 18, p. 697.
New rules proposed for distribution of empty coal cars. (2 800 words & fig.)

1922 624 .63 (.73)
Railway Review, No. 21, November 18, p. 700.
TAYLOR (D. M.). — North Hill viaduct, Akron, Ohio, completed. (2 000 words & fig.)

1922 621 .132.8 (.73)
Railway Review, No. 21, November 18, p. 718.
Gasoline motor car train for M. & P. Ry. (1 000 words & fig.)

1922 625 .245 (.73)
Railway Review, No. 22, November 25, p. 731.
Design of automobile car presents special problems. (3 300 words & fig.)

1922 621 .134.2
Railway Review, No. 22, November 25, p. 743.
A new construction in locomotive power reverse gears. (1 700 words & fig.)

1922 621 .139 & 625 .18
Railway Review, No. 23, December 2, p. 773.
The custody and delivery of railway material. (2 000 words & fig.)

1922 625 .245
Railway Review, No. 23, December 2, p. 777.
Container car for milk shipments. (900 words & fig.)

1922 621 .132.3 & 621 .132.5
Railway Review, No. 23, December 2, p. 779.
BULKELEY (G.). — The consolidation type for both freight and passenger service. (2 400 words & fig.)

1922 621 .133.5
Railway Review, No. 24, December 9, p. 809.
COPPUS (F. H. C.). — The mechanical drafting of steam locomotives. (4 000 words & fig.)

1922 621 .134.2
Railway Review, No. 24, December 9, p. 813.
HARTMAN (G. H.). — Effect of locomotive valve motions on steam distribution. (4 000 words & fig.)

1922 625 .18 (.73) & 625 .245 (.73)
Railway Review, No. 25, December 16, p. 847.
The custody and delivery of railway materials. (2 100 words & fig.)

1922 621 .132.8
Railway Review, No. 25, December 16, p. 852.
ZEITLER (R. S.). — Novel gasoline motor truck for railway car bodies. (1 900 words & fig.)

1922 625 .142.2
Railway Review, No. 25, December 16, p. 854.
Preservative treatment of ties and timber. (6 500 words & fig.)

1922 625 .13 (.73)
Railway Review, No. 25, December 23, p. 887.
Rebuilding Niagara bridge of the Michigan Central R. R. (1 600 words & fig.)

1922 621 .133.3
Railway Review, No. 25, December 23, p. 892.
SELEY (C. A.). — A new measuring stick for locomotive boiler proportions. (3 900 words.)

1922 621 .131.2
Railway Review, No. 26, December 23, p. 897.
GREENOUGH (Grafton). — Some recent developments in locomotive construction. (1 600 words.)

1922 625 .2
Railway Review, No. 26, December 23, p. 898.
VIBERG (E. R.). — Present day tendencies in car construction. (3 700 words, 2 tables & fig.)

1922 625 .245
Railway Review, No. 26, December 23, p. 902.
WELCKER (R.). — A rotary tank car for transportation of bulk materials. (1 800 words & fig.)

1922 621 .7 (.73)
Railway Review, No. 27, December 30, p. 927.
If interested in railway shop efficiency and output-read this. (4 800 words & fig.)

1922 385. (07.12 (.73)
Railway Review, No. 27, December 30, p. 935.
The merits of shop training and apprentice systems. (4 500 words.)

1923 621 .132 (.73)
Railway Review, No. 1, January 6, p. 11.
More locomotives retired than added to class I railways in 1922. (350 words, fig. & tables.)

Railway Signal Engineer. (Chicago.)

1922 656 .256 (.73) & 656 .257 (.73)
Railway Signal Engineer, No. 12, December, p. 465.

Signaling meadows line of D. L. & W. (4 300 words & fig.)

1922 656 .253
Railway Signal Engineer, No. 12, December, p. 484.

HOLT (T.). — **Signaling busy passenger terminals.** (1 000 words & fig.)

1922 656 .253
Railway Signal Engineer, No. 12, December, p. 485.

PORTER (L. C.) & BROE (A. L.). — **The electric lamp for railway signals.** (4 800 words & fig.)

Tramway and Railway World. (London.)

1922 621 .335 (.73)
Tramw. & Ry. World, No. 29, December 14, p. 297.

SMITH (H. K.). — **Some records of electric locomotives and motor cars in American railway service.** (2 300 words & fig.)

1922 621 .335 (.68)
Tramw. & Ry. World, No. 29, Decembe 14, p. 303.

Electric locomotives for South African Railways. (1 000 words & fig.)

1922 625 .252
Tramw. & Ry. World, No. 29, December 14, p. 305.

Brake shoe hanger and bracket. (300 words & fig.)

Transport & Travel Monthly. (London.)

1922 625 .25 (.42)
Transport & Travel Monthly, No. 152, December, p. 370.

Automatic breaks for freight trains. (5 900 words & fig.)

In Italian.

Giornale del genio civile. (Roma.)

1922 623 (.45)
Giornale del genio civile, 30 novembre, p. 706.

L'opera del genio civile nella Guerra nazionale 1915-1918. (10 000 parole.)

1922 389
Giornale del genio civile, 30 novembre, p. 742.

La standardizzazione e la serie metrica - Standard. (5 900 parole & 1 tavola.)

Rivista tecnica delle ferrovie italiane. (Roma.)

1922 621 .132.6 (.45)
Rivista tecnica delle ferrovie, No. 5, 15 novembre, p. 317.

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1923 385 .581
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PONÇAY (H.). — La **journée de huit heures** et sa répercussion sur la production. (3 300 mots.)

1923 669 .1
Génie civil, n° 2114, 17 février, p. 151.
La **trempe** de l'**acier** et des **alliages** métalliques. (4 500 mots & fig.)

1923 621 .116 (.73)
Génie civil, n° 2114, 17 février, p. 154.
Le chauffage au **charbon pulvérisé** de la Centrale de Milwaukee et de l'usine de l'United Railways C°, à Providence (E.-U.). (1 400 mots, 1 tableau & fig.)

1923 721 .9
Génie civil, n° 2114, 17 février, p. 161.
L'emploi de barres d'acier écrouies par étirage pour les ouvrages en **béton armé.** (900 mots.)

1923 621 .95 & 625 .13
Génie civil, n° 2116, 3 mars, p. 193.
La machine à creuser les **tunnels,** système Whitaker. (1 600 mots & fig.)

1923 621 .336
Génie civil, n° 2116, 3 mars, p. 209.
L'emploi des commutatrices pour la **transformation du courant alternatif en courant continu** dans les exploitations de chemins de fer. (1 000 mots.)

1923 621 .138.2 (.44)
Génie civil, n° 2117, 10 mars, p. 235.
La manutention des combustibles dans les dépôts de locomotives, par les distributeurs du système Marie. (400 mots & fig.)

1923 656 .211.7 (.82)
Génie civil, n° 2118, 17 mars, p. 245.
GUERIN (H.). — Le **pont à transbordeur** sur le Riachuelo à Buenos-Ayres. (3 500 mots & fig.)

La Science et la Vie. (Paris.)

1923 721 .9 (.44)
La Science et la Vie, février, p. 103.
DERMOND (M.). — On construit près de Paris les deux plus grands **hangars du monde.** (3 000 mots & fig.)

Les chemins de fer et les tramways. (Paris.)

1923 621 .132.8 (.44) & 621 .335 (.44)
Les chemins de fer et les tramways, 31 mars, p. 470.
MINISTÈRE DES TRAVAUX PUBLICS. — Commission relative à l'utilisation des **automotrices sur rails.** Rapport de la Commission. (15 400 mots, tableaux & fig.)

L'Industrie des tramways et chemins de fer. (Paris.)

1923 621 .33 (.44)
L'Industrie des tramw. et ch. de fer, janvier, p. 17.
Inauguration des premières **installations électriques à courant continu** du chemin de fer du Midi, le 30 octobre 1922. (3 000 mots & fig.)

1923 621 .33 (.44)
L'Indust ie des tramw. et ch. de fer, janvier, p. 20.
L'électrification d'une partie du réseau des chemins de fer du Midi. (3 400 mots, 4 tableaux & fig.)

Revue générale des chemins de fer et des tramways. (Paris.)

1923 621 .335
Revue générale des ch. de fer, février, p. 105.
BIANCHI (J.). — Nouveau type de transmission par bielles pour **locomotives électriques.** (1 500 mots & fig.)

1923 621 .32 & 656 .215
Revue générale des ch. de fer, février, p. 113.
GIRAULT (Th.). — Contrôle des **consommations d'électricité des gares,** dépôts, etc., par les consommations normales. (3 500 mots, tableau & fig.)

1923 621 .33 (.44)
Revue générale des ch. de fer, mars, p. 181.
LEBOUCHER (P.) & LEDOUX (H.). — Note sur **l'électrification des chemins de fer du Midi.** (14 600 mots, tableaux & fig.)

1923 656 .281
Revue générale des ch. de fer, mars, p. 226.
PERRET (J.). — Note sur les **déraillements** par **aiguilles entrebaillées.** (3 900 mots & fig.)

1923 621 .335 (.494)
Revue générale des ch. de fer, mars, p. 249.
Nouvelle **locomotive électrique** à grande vitesse des chemins de fer fédéraux suisses. (1 000 mots & fig.)

1923 621 .132.8 (.494) & 621 .43 (.494)
Revue générale des ch. de fer, mars, p. 251.
Voiture **automotrice** à moteur Diesel. (1 100 mots & fig.)

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1923 — 621 .33 (.44)

Revue politique et parlementaire, 10 mars, p. 492.

ALLIX (G.). — Revue des questions de transport. **L'électrification des chemins de fer.** (5 000 mots.)

In German.

Glasers Annalen. (Berlin.)

1923 — 621 .133. (01

Glasers Annalen, Heft 1, 1. Januar, S. 2.

WITTFELD. — **Lokomotive** mit veränderlicher Uebersetzung. (1 800 Wörter & Abb.)

1923 — 621 .133.2

Glasers Annalen, Heft 2, 15. Januar, S. 22.

LORENZ. — Mitteilungen über **Zwillingstehbolzen.** (5 900 Wörter & fig.)

1923 — 656 .212.6

Glasers Annalen, Heft 2, 15. Januar, S. 33.

HERMANNS (H.). — Eine bemerkenswerte **Anlage von Schüttgut.** (600 Wörter & Abb.)

1923 — 625 .2 (01

Glasers Annalen, Heft 4, 15. Februar, S. 62.

GOTTSCHALK. — Normen im **Eisenbahnwagenbau.** (1 600 Wörter & Abb.)

1923 — 621 .133. (01

Glasers Annalen, Heft 5, 1. März, S. 69.

LORENZ (R.). — **Dampflokomotiven mit Kondensation.** (6 000 Wörter, 13 Tabellen & Abb.)

Organ für die Fortschritte des Eisenbahnwesens (Berlin und Wiesbaden.)

1922 — 621 .132.5 (.47)

Org. für die Fortschr. des Eis., Heft 24, 15. Dez., S. 329.

MEINEKE (F.). — Die **Russische E-Heissdampf-Güter-Lokomotive** und ihre Erprobung. (2 000 Wörter & Abb.)

1922 — 625 .17

Org. für die Fortschr. des Eis., Heft 24, 15. Dez., S. 332.

MAILE (G.). — Schmieren der Spurkränze zur **Schonung und Erhaltung von Rad und Schiene.** (1 000 Wörter & Abb.)

1922 — 625 .143.5

Org. für die Fortschr. des Eis., Heft 24, 15. Dez., S. 333.

HELMKE (R.). — **Schienenbefestigung** auf Mauerwerk. (500 Wörter & Abb.)

1922 — 621 .135.4

Org. für die Fortschr. des Eis., Heft 24, 15. Dez., S. 341.

Bewegliche Lagerung einzelner **treibender Achsen** im Hauptrahmen. (800 Wörter & Abb.)

Zeitschrift des Vereines deutscher Ingenieure. (Berlin.)

1923 — 62. (01

Zeitschr. Ver. deutsch. Ing., Nr. 4, 27. Januar, S. 74.

MOHR (F.). — Neuzeitliche **Prüfmaschinen** und **Prüfeinrichtungen.** (1 400 Wörter & Abb.)

1923 — 62. (01 & 669

Zeitschr. Ver. deutsch. Ing., Nr. 6, 10. Februar, S. 122.

LUDWIK (P.) & SCHEU (R.). — **Das Verhalten der Metalle** bei wiederholter **Beanspruchung.** (4 000 Wörter & Abb.)

1923 — 621 .9 (.43)

Zeitschr. Ver. deutsch. Ing., Nr. 9, 3 März, S. 201.

BRASCH (H. D.). — Neue **Werkzeugmaschinen** auf der Leipziger Frühjahrsmesse 1923. (2 600 Wörter, 2 Tabellen & Abb.)

Zeitung des Vereins deutscher Eisenbahnverwaltungen. (Berlin.)

1923 — 656 .235.7

Zeitung des Vereins, Nr. 3, 18. Januar, S. 41.

REFFLER. — Die wirtschaftliche Bedeutung der **Umladekosten für Stückgut.** (4 000 Wörter.)

In English.

American Railway Association (New York).

1923 — 656 .25 (01

Amer. Ry. Ass^{on}, signal section, advance notice, annual meeting, March 13, 14 and 15.

Committee XIX. — Economics of railway signaling. (2 500 words & tables.)

Bulletin, American Railway Engineering Association. (Chicago.)

1922 — 625 .143.3

Bull. Amer. Ry. Eng. Ass^{on}, November, p. 73.

Report of Committee IV : **Rail.** (5 400 words, tables & fig.)

1922 — 625 .144.4

Bull. Amer. Ry. Eng. Ass^{on}, November, p. 101.

Report of Committee II : **Ballast.** (9 600 words, tables & fig.)

1922 — 625 .111 (.73)

Bull. Amer. Ry. Eng. Ass^{on}, November, p. 121.

Report of Committee IX : **Signs, fences and crossings.** (4 300 words & fig.)

1922 — 691 (.73) & 721 .9 (.73)

Bull. Amer. Ry. Eng. Ass^{on}, November, p. 133.

Report of Committee VIII : **Masonry.** (3 800 words, 1 table & fig.)

1923 — 625 .14 (01

Bull. Amer. Ry. Eng. Ass^{on}, January, p. 297.

Third progress report of the special committee on **stresses in railroad track.** (40 000 words & fig.)

1923 625 .14
Bull. Amer. Ry. Eng. Ass^on, January, p. 451.
Report of Committee V : **Track.** (12 000 words, 6 tables & fig.)

1923 625 .14 (01
Bull. Amer. Ry. Eng. Ass^on, January, p. 533.
Report of Committee XII : **Rules and organization.** (11 000 words & fig.)

1923 725 .3 (.73)
Bull. Amer. Ry. Eng. Ass^on, February, p. 689.
Report of Committee VI : **Buildings.** (30 000 words, 2 tables & fig.)

1923 624. (01
Bull. Amer. Ry. Eng. Ass^on, February, p. 751.
Report of Committee VII : **Wooden bridges** and trestles. (12 000 words, 1 table & fig.)

1923 313 : 625 (.73)
Bull. Amer. Ry. Eng. Ass^on, February, p. 777.
Report of Committee XI : **Records and accounts.** (8 400 words & fig.)

1923 656 .21 (.73)
Bull. Amer. Ry. Eng. Ass^on, March, p. 809.
Report of Committee XIV : **Yards and terminals** (35 000 words, 24 tables & fig.)

1923 691 (.73)
Bull. Amer. Ry. Eng. Ass^on, March, p. 943.
Report of Committee XVII : **Wood preservation.** (34 600 words, tables & fig.)

1923 385 .11 (.73)
Bull. Amer. Ry. Eng. Ass^on, March, p. 1043.
Report of Committee XXI : Economics of **railway operation.** (16 800 words, tables & fig.)

Electric Railway Journal. (New York.)

1923 388 (.73 + .4)
Electric Railway Journal, No. 2, January 13, p. 79.
TURNER (D. L.). — **New York, London, Paris and Berlin transit** compared. (6 000 words, 2 tables & fig.)

1923 621 .333
Electric Railway Journal, No. 3, January 20, p. 111.
DEAN (J. S.).— Maintaining **electric railway motors.** (5 400 words, tables & fig.)

1923 625 .14 (.73)
Electric Railway Journal, No. 3, January 20, p. 117.
Features of 1922 **trackwork** in Rochester. (1 000 words & fig.)

1923 625 .143.5
Electric Railway Journal, No. 3, January, 20, p. 131.
Eccentric **grip washer.** (500 words & fig.)

1923 621 .335
Electric Railway Journal, No. 5, February 3, p. 199.
DÖRY (I.). — A. C. **locomotive control.** (1 300 words & fig.)

1923 621 .335 (.73)
Electric Railway Journal, No. 10, March 10, p. 412.
CLARDY (W. J.). — **New 180- ton passenger locomotives** for the New Haven. (1 100 words.)

1923 621 .331 (.73)
Electric Railway Journal, No. 11, March 17, p. 439.
Power generation costs reduced 35 per cent. (4 200 words & fig.)

1923 385 .523 (.73)
Electric Railway Journal, No. 11, March 17, p. 443.
Piece-work system in car maintenance. (2 000 words, tables & fig.)

Engineer. (London.)

1923 621 .9
Engineer, No. 3500, January 26, p. 96.
Machine tools for **locomotive work.** (1 500 words.)

1923 621 .86 (.41)
Engineer, No. 3500, January 26, p. 98.
Transporter for Ireland. (1 200 words & fig.)

1923 624 .2
Engineer, No. 3501, February 2, p. 124.
HOOD (T. C.). — **Girder bridge** design. (3 000 words.)

1923 656 .212.6
Engineer, No. 3502, February 9, p. 153.
An electric **runabout crane.** (1 300 words & fig.)

1923 621 .33 (.43)
Engineer, No. 3503, February 16, p. 169.
The **electrification** of the German Railways. (2 200 words.)

1923 62. (01
Engineer, No. 3503, February 16, p. 182.
LEA (F. C.). — **Tensile tests of materials** at high temperatures. (2 600 words, 3 tables & fig.)

1923 621 .132.3 (.42)
Engineer, No. 3504, February 23, p. 200.
MAUNSELL (R. E. L.). — Southern Railway three-cylinder simple **superheater locomotive.** (800 words & fig.)

1923 621 .39 (.494) & 625 .234 (.494)
Engineer, No. 3504, February 23, p. 209.
A 15 000-volt electric **heating wagon.** (600 words, table & fig.)

1923 656 .222.1 (.42)
Engineer, No. 3505, March 2, p. 220.
Great Western **express running** : Birmingham-Paddington. (3 500 words & 2 tables.)

1923 621 .110
Engineer, No. 3505, March 2, p. 236.
Engine **indicators.** (1 100 words & fig.)

1923 621 .110
Engineer, No. 3505, March 2, p. 238.
WIMPERIS (H. E.). — New means of ascertaining mean pressure in a **heat engine.** (2 000 words & fig.)

1923 656 .257 (.42)
Engineer, No. 3506, March 9, p. 251.
Route signalling at Winchester, Great Western Railway. (2 700 words & fig.)

1923 621 .132.6 & 621 .134.3
Engineer, No. 3506, March 9, p. 255.
BREWER (F. W.). — **Superheater tank locomotives** in suburban service. (2 500 words.)

1923 621 .133
Engineer, No. 3507, March 16, p. 279.
Condensing and utilisation of **exhaust steam in locomotives.** (3 800 words & fig.)

1923 624 .63 (.42)
Engineer, No. 3508, March 23, p. 313.
New bridge at Muskham on the Great North Road. (1 500 words & fig.)

Engineering. (London.)

1923 621 .95 & 625 .13
Engineering, No. 2978, January 26, p. 102.
The Whitaker **tunnelling machine.** (1 200 words & fig.)

1923 625 .13 (.73)
Engineering, No. 2983, March 2, p. 266.
Driving 250-ft. piles for the **Hudson river tunnel.** (1 400 words & fig.)

1923 721 .9
Engineering, No. 2985, March 16, p. 319.
Reinforced concrete pier at Shellhaven. (2 700 words & fig.)

Engineering News-Record. (New York.)

1923 691 & 721 .9
Engineering News-Record, No. 1, January 4, p. 32.
A résumé of criticisms of the joint committee report in the discussion of **concrete specifications.** (2 000 words.)

1923 624 .63
Engineering News-Record, No. 2, January 11, p. 73.
HAYDEN (A. G.). — Continuous frame design used for **concrete highway bridges.** (1 800 words & fig.)

1923 624 .63 (.73)
Engineering News-Record, No. 3, January 18, p. 108.
HAYDEN (A. G.). — Tests of knees for continuous **frame concrete bridges.** (1 400 words, 1 table & fig.)

1923 624 .63 (.73)
Engineering News-Record, No. 4, January 25, p. 148.
Design of 400-ft. **concrete arch** of the Cappelen memorial bridge. (3 000 words & fig.)

1923 625 .144.4 (.73)
Engineering News-Record, No. 4, January 25, p. 164.
Rail reclamation practice on the Illinois Central R. R. (900 words & fig.)

1923 624 .1
Engineering News-Record, No. 4, January 25, p. 171.
Sinking a large **cofferdam crib.** (1 000 words & fig.)

1923 721 .9
Engineering News-Record, No. 5, February 1, p. 194.
KOPPEN (E. C.). — **Precast concrete flume** on Klamath project. (4 800 words, 3 tables & fig.)

1923 625 .111
Engineering News-Record, No. 5, February 1, p. 202.
EWALD (W.). — **Surveying** without instruments on Siberian Railway. (1 000 words & fig.)

1923 721 .1 (.73)
Engineering News-Record, No. 5, February 1, p. 219.
Foundation and scour protection of large power station on Mississippi River. (1 600 words & fig.)

1923 625 .13 (.73) & 721 .3 (.73)
Engineering News-Record, No. 6, February 8, p. 242.
Driving 250-ft. piles for Hudson River **tunnel shaft.** (4 300 words & fig.)

1923 621 .87 (.73)
Engineering News-Record, No. 6, February 8, p. 250.
Travelling crane has turntable to swing locomotives. (700 words & fig.)

1923 624 .3
Engineering News-Record, No. 7, February 15, p. 302.
Force-account **bridge building** in South Dakota. (1 600 words & fig.)

1923 624 .63
Engineering News-Record, No. 8, February 22, p. 355.
Concrete arch rib fails due to laitance at joint. (900 words & fig.)

1923 624 .62
Engineering News-Record, No. 9, March 1, p. 380.
Long-span **steel arch bridge** over Niagara Gorge for Michigan Central R. R. (4 500 words & fig.)

1923 532 (.45)
Engineering News-Record, No. 9, March 1, p. 389.
GUTMANN (I.). — The **Apulian aqueduct** southern Italy's water supply. (5 800 words, 2 tables & fig.)

1923 625 .1
Engineering News-Record, No. 10, March 8, p. 438.
TRATMAN (E. E. R.). — Developments in **railway maintenance-of-way** methods. (6 300 words.)

1923 625 .14 (01
Engineering News-Record, No. 10, March 8, p. 445.
Further track test data : **rail stresses and track distortion** on curves. (4 500 words, 2 tables & fig.)

1923 624 .32 (.7)
Engineering News-Record, No. 11, March 15, p. 476.
MEARS (F.). — **Bridging the Tanana River** on the Alaska Railroad. (4 800 words & fig.)

Great Western Railway Magazine. (London.)

1923 **625 .13 (.42)**
Great Western Railway Magazine, January, p. 20.
WARREN (F. C.). — **The Severn tunnel.** (3 200 words & fig.)

Journal of the Institute of transport. (London.)

1923 **625 .24 (.42)**
Journal of the Institute of Transport, March, p. 152.
Wagon stock on British railways. (9 200 words, 3 tables & fig.)

1923 **656 .211 (.42)**
Journal of the Institute of Transport, March, p. 166.
The modernisation of **passenger railway stations.** (8 300 words.)

Journal Permanent Way Institution. (London.)

1922 **625 .4 (.42) & 625 .13 (.42)**
Journal, Perm. Way Inst., December, p. 215.
DALRYMPLE-HAY (H. H.). — Some facts about the construction of the **London tube railway.** (9 800 words & fig.)

1922 **625 .13**
Journal, Perm. Way Inst., December, p. 236.
FLETCHER (B. P.). — **The renewal of bridges.** (8 300 words & fig.)

1922 **656 .212.8**
Journal, Perm. Way Inst., December, p. 265.
APPLEYARD (T.). — **Out-of-gauge loads** and structure gauges, etc. (6 200 words & fig.)

Mechanical Engineering. (New York.)

1923 **621 .138 (.73)**
Mechanical Engineering, February, p. 83.
HUNTER (J.) & COTTON (A.). — Methods of **ash handling.** (7 000 words & fig.)

1923 **385. (07 .12 (.73)**
Mechanical Engineering, March, p. 173.
SACKETT (R. L.). — **Schools for apprentices** and shop training. (3 600 words.)

Proceedings, American Society of Civil Engineers. (New York.)

1923 **385 .114 (.71) & 656 .232 (.71)**
Proceed. Amer. Soc. Civil Eng., January, p. 3.
NEWELL (J. P.). — Analysis of **cost of freight service,** Grand Trunk Railway Company of Canada. (10 000 words, 11 tables & fig.)

1923 **624. (01 (.73)**
Proceed. Amer. Soc. Civil Eng., January, p. 53.
Special committee on specifications for **bridge design and construction.** (9 200 words, 20 tables & fig.)

1923 **721 .9**
Proceed. Amer. Soc. Civil Eng., February, p. 165.
TUCKER (J.). — **Reinforced concrete columns.** (23 000 words, 13 tables & fig.)

1923 **624 .6**
Proceed. Amer. Soc. Civil Eng., February, p. 251.
WIGGIN (Th. H.). — The comparison of **concret groined arches** as an aid in their design. (4 000 words 7 tables & fig.)

1923 **625 .14 (0**
Proceed. Amer. Soc. Civil Eng., March, p. 295.
Third progress report of the special committee t report on **stresses in railroad track.** (34 500 words 23 tables & fig.)

1923 **624 .2 & 721 .9**
Proceed. Amer. Soc. Civil Eng., March, p. 457.
Progress report of the special committee on **impact in highway bridges.** (5 300 words, 12 tables & fig.)

1923 **385. (07 .11**
Proceed. Amer. Soc. Civil Eng., March, p. 491.
Engineering education. (8 700 words.)

Proceedings, Institution of Mechanical Engineers. (London.)

1922 **621 .114, 621 .135.2 & 625 .214**
Proceed. Institut. of Mechan. Eng., December, p. 1117.
STANTON (T. E.). — Some recent researches on **lubrication.** (11 000 words, 2 tables & fig.)

Railway Age. (New York.)

1923 **621 .13 (.3)**
Railway Age, No. 1, January 6, p. 41.
STUEBING (A. F.). — A year of innovations in **locomotive design.** (1 900 words & fig.)

1923 **621 .33 (.73)**
Railway Age, No. 1, January 6, p. 45.
OEHLER (A. G.). — What railroads are doing with **electric traction.** (5 000 words & fig.)

1923 **385. (09.1 (.42)**
Railway Age, No. 1, January 6, p. 55.
FRASER (W. H.). — **British railway** show progress during 1922. (3 900 words, 2 tables & fig.)

1923 **385 .15 (.45)**
Railway Age, No. 1, January 6, p. 62.
GIORDANO (A.). — Italy plans return to **private ownership.** (2 200 words & fig.)

1923 **385. (09.1 (.47)**
Railway Age, No. 1, January 6, p. 65.
BARBER (Col. A. B.). — **Polish railways** make great strides in 1922. (5 400 words & fig.)

1923 **313 .385 (.73)**
Railway Age, No. 1, January 6, p. 112.
PARMELEE (J. H.). — An analysis of the **railway statistics for 1922.** (4 000 words, 9 tables & fig.)

1923 **624 .62 (.73)**
Railway Age, No. 2, January 13, p. 176.
Michigan Central to build **new bridge** at Niagara. (3 000 words & fig.)

1923 385 .14 (.71)
Railway Age, No. 2, January 13, p. 181.
SHIRLEY EATON (J.) — New England divisions and transportation act. (4 500 words.)

1923 621 .133.3
Railway Age, No. 2, January 13, p. 189.
SELEY (C. A.). — Graphic presentation of boiler proportions. (2 000 words & fig.)

1923 621 .138.5 (.73) & 621 .9 (.73)
Railway Age, No. 3, January 20, p. 219.
WOODWARD (E. L.). — Lack of modern machinery handicaps railroads. (3 800 words, 1 table & fig.)

1923 625 .14 (01
Railway Age, No. 3, January 20, p. 229.
The stresses in straight and curved track. (5 000 words & fig.)

1923 656 .211.4 (.73) & 725 .31 (.73)
Railway Age, No. 4, January 27, p. 263.
Chicago gets a new passenger terminal plan. (1 900 words & fig.)

1923 621 .132.8 (.73)
Railway Age, No. 4, January 27, p. 273.
Gasoline rail car shows good fuel economy. (1 500 words & fig.)

1923 725 .33 (.73)
Railway Age, No. 4, January 27, p. 281.
An innovation in locomotive terminal design. (2 800 words & fig.)

1923 625 .112 (.3)
Railway Age, No. 5, February 3, p. 319.
Railway gages throughout the world. (1 100 words.)

1923 621 .131.2
Railway Age, No. 5, February 3, p. 323.
STUEBING (A. F.). — The next step in locomotive construction. (3 300 words.)

1923 621 .335 (.494)
Railway Age, No. 6, February 10, p. 377.
Sulzer Diesel-electric rail motor car. (1 500 words & fig.)

1923 725 .33 (.73)
Railway Age, No. 7, February 17, p. 415.
M. K. & T. builds new terminal at Denison. (2 100 words & fig.)

1923 621 .33 (.73 + .4)
Railway Age, No. 7, February 17, p. 423.
POTTER (W. B.). — Observations on electric railway practice. (4 000 words & fig.)

1923 385. (01 (.51)
Railway Age, No. 8, February 24, p. 458.
Shantung Railway turned over to Chinese. (4 000 words & fig.)

1923 621 .13 (06.4 (.81)
Railway Age, No. 8, February 24, p. 467.
Locomotives for Brazilian centennial exhibition. (1 000 words & fig.)

1923 621 .138.3
Railway Age, No. 8, February 24, p. 473.
Report of the Bureau of locomotive inspection. (1 100 words, tables & fig.)

1923 625 .142.2 & 691
Railway Age, No. 9, March 3, p. 504.
TAYLOR (C. M.). — Creosote shortage threatens wood preservation. (2 600 words & fig.)

1923 621 .132.5 (.73)
Railway Age, No. 9, March 3, p. 511.
Heavy Mikado type locomotives for D. L. & W. (1 600 words & fig.)

1923 625 .214
Railway Age, No. 9, March 3, p. 516.
BRUNNER (H. E.). — Advantages of the spherical type roller bearing. (1 700 words & fig.)

1923 621 .131.2
Railway Age, No. 10, March 10, p. 553.
BASFORD (G. M.). — As to the locomotive. What next? (6 600 words, 1 table & fig.)

1923 625 .144.4 (.73)
Railway Age, No. 10, March 10, p. 559.
MOORE (G. L.). — Mechanical equipment saves men and money. (4 000 words & fig.)

1923 656 .253 (.73)
Railway Age, No. 10, March 10, p. 575.
DODGSON (F. L.). — How automatic train control affects operation. (5 000 words & fig.)

1923 656 .222 (.73)
Railway Age, No. 11, March 17, p. 755.
« Peg » system expedites freight train movement. (1 600 words, tables & fig.)

1923 621 .138.1 (.73)
Railway Age, No. 11, March 17, p. 759.
Railway officers discuss locomotive terminals. (7 800 words & fig.)

1923 621 .335 (.73)
Railway Age, No. 11, March 17, p. 767.
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O'CONNOR (W. J.). — Successful **lubrication** of journal boxes. (3 700 words.)

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Operating, mechanical and engineering departments contribute symposium on **locomotive terminals** before Western Society of Engineers. (13 800 words & fig.)

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Railway Signal Engineer, March, p. 117.
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Standard specifications for steel highway bridges.
Ottawa, Ont. Canadian Engineering Standards Asso ciation, West Block. (6 × 9 inches), 75 pages, illust (Price : 25 cents.)

1923 313 .385 (.73
Statistics of railways in the United States, 1920.
Washington, D. C. Insterstate Commerce Commission (9 × 12 inches), 471 pages.

1923 385 (.73
The consolidation of railroads in the United States Report of National Industrial Conference Board.
Harvard University. Reviewed by Wm. J. Cunning ham, professor of transportation. 107 pages.

1923 385. (0
The Railway Diary and Officials' Directory, 1923.
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1923 385. (0
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1923 669. (0
VICKERS (Charles).
Metals and their alloys.
New York. Published by Henry Carey Baird & Co (6 × 9 inches), 800 pages & 110 illustrations.

[016 .385. (05]

II. — PERIODICALS.

In French.

Annales des ponts et chaussées. (Paris.)

1923 621 .132.8 (.44) & 621 .335 (.44)

Ann. des ponts et chauss., part. techn., janv.-fév., p. 74.

Utilisation des automotrices sur rails. Rapport de la Commission instituée par M. le Ministre des travaux publics. (11 500 mots & 1 tableau.)

Arts et Métiers. (Paris.)

1923 624 .63 (.44)

Arts et Métiers, février, p. 476.

BERNARD (F.). — Construction d'un pont route de 92 mètres de portée sur la Loire, à Nantes. (1 700 mots & fig.)

Bulletin des renseignements frigorifiques. (Paris.)

1923 625 .244

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HIRSCH. — Wagons refroidis mécaniquement. (1 500 mots.)

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1923 621 .134.3

Bull. de la Soc. d'enc. pour l'ind. nat., avril, p. 299.

SAUVAGE (E.). — Réchauffeurs d'eau d'alimentation pour locomotives. (2 700 mots & fig.)

Bulletin technique de la Suisse romande. (Lausanne.)

1923 621 .87

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DRUCY (W.). — Portique roulant de 25 tonnes, avec commande électrique, à la gare des marchandises de Zurich. (1 400 mots & fig.)

Bulletin des transports internationaux par chemins de fer. (Berne.)

1923 385 .581 (.44)

Bull. des transp. intern. par ch. de fer, mars, annexe.

Décret réglementant la durée du travail des agents de chemins de fer autres que les mécaniciens, chauffeurs et agents des trains. (2 800 mots.)

Génie civil. (Paris.)

1923 62. (01

Génie civil, n° 2120, 31 mars, p. 303.

MALAVAL. — Loi des déformations permanentes à la traction et à la compression. (2 400 mots & fig.)

1923 621 .87 (.44)

Génie civil, n° 2122, 14 avril, p. 341.

Grue pivotante et basculante de 60 tonnes, installée aux chantiers navals d'Harfleur (Seine-Inférieure) (1 500 mots & fig.)

1923 51. (08

Génie civil, n° 2122, 14 avril, p. 350.

DEGUILLAUME (R.). — L'utilisation d'une règle à calcul pour l'étude des projets de béton armé. (3 200 mots & fig.)

1923 62. (01

Génie civil, n° 2125, 5 mai, p. 421.

LEGENS (L.). — Calcul de l'arc à deux rotules. (1 300 mots & fig.)

1923 621 .132.7 (.44)

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Locomoteur à essence, système Vermot, pour la manœuvre des wagons. (900 mots & fig.)

Revue générale des chemins de fer et des tramways. (Paris.)

1923 385. (01 (.56)

Revue générale des ch. de fer, avril, p. 263.

POURCEL. — Notes de voyage en Syrie avec la mission d'études économiques. (3 300 mots & fig.)

1923 621 .132.8

Revue générale des ch. de fer, avril, p. 272.

BRILLIÉ (E.). — Application du moteur à hydrocarbures à la traction sur voies ferrées. (9 000 mots, 2 tableaux & fig.)

1923 725 .33 (.44)

Revue générale des ch. de fer, avril, p. 306.

SIGMANN (A.). — L'équipement frigorifique du réseau d'Orléans et la gare frigorifique de Paris-Ivry (P. O.). (2 800 mots & fig.)

1923 385 .113 (.44)

Revue générale des ch. de fer, avril, p. 319.

Résultats obtenus en 1921 sur le réseau des chemins de fer de l'Etat en France, d'après les comptes d'administration publiés pour ladite année. (1 000 mots & 12 tableaux.)

1923 656 .281

Revue générale des ch. de fer, mai, p. 415.

DESCUBES. — Note relative aux déraillements sur les aiguilles. (1 200 mots & fig.)

1923 385 .1 (.494)

Revue générale des ch. de fer, mai, p. 435.

Le budget des chemins de fer fédéraux pour 1923. (2 200 mots & 1 tableau.)

Revue universelle des mines, de la métallurgie, des travaux publics, des sciences et des arts appliqués à l'industrie. (Liége.)

1923 621 .39
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BECKERS (A.), LAGRANGE (D.) & TONDELIER (H.). — Emploi de la **soudure électrique** dans les constructions métalliques. (10 200 mots & fig.)

1923 62. (01 & 691
Revue universelle des mines, n° 6, 15 mars, p. 411.
MARNEFFE (A. de). — Essais de **poutres double T** en fonte armée d'acier. (4 300 mots, 2 tableaux & fig.)

In German.

Archiv für Eisenbahnwesen. (Berlin.)

1923 656 .212.5 (.43)
Archiv für Eisenbahnwesen, Januar u. Februar, S. 1.
KÜMMELL. — Die Betriebskosten der **Verschiebebahnhöfe.** (6 300 Wörter & 4 Tabellen.)

1923 385 .589 (.73)
Archiv für Eisenbahnwesen, Januar u. Februar. S. 65.
Der **Ausstand der Eisenbahn-Werkstattenarbeiter** in den Vereinigten Staaten von Amerika. (6 500 Wörter.)

1923 313 .385 (.43) & 385 .113 (.43)
Archiv für Eisenbahnwesen, Januar u. Februar, S. 82.
Die **Deutsche Reichsbahn** in ihrem ersten Betriebsjahr. (10 800 Wörter & Tabellen.)

1923 656 .27 (.431)
Archiv für Eisenbahnwesen, Januar u. Februar, S. 142.
Entwicklung der **nebenbahnähnlichen Kleinbahnen** in Preussen. (4 000 Wörter & Tabellen.)

Zeitschrift für das gesamte Eisenbahn-Sicherungswesen. (Berlin.)

1923 656 .254
Zeitschr. für das ges. Eis. Sicher., Nr. 5, 10. April, S. 62.
CALM (D.). — Neuerungen in **Fernmelde- und Stromversorgungsanlagen.** (6 000 Wörter & Abb.)

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1923 669 .1 & 62 (01
Zeitschr. Ver. deutsch. Ing., Nr. 15, 14. April, S. 357.
MÜLLER (W.) & LEBER (H.). — Beanspruchungshöhe, Korngrösse und Temperatur bei **Ermüdungserscheinungen.** (4 500 Wörter, 5 Tabellen & Abb.)

1923 625 .24 (01 (.73)
Zeitschr. Ver. deutsch. Ing., Nr. 15, 14. April, S. 364.
REDER (G.). — Amerikanische **Grossgüterwagen.** (1 800 Wörter, 1 Tabelle & Abb.)

Zeitung des Vereins deutscher Eisenbahnverwaltungen. (Berlin.)

1923 625 .172
Zeitung des Vereins, Nr. 10, 8. März, S. 167.
PONFICK. — Wirtschaftlichere Arbeitsweise bei der **Unterhaltung der Bahnanlagen.** (4 800 Wörter.)

1923 621 .33 (.494)
Zeitung des Vereins, Nr. 10, 8. März, S. 171.
Elektrisierung der Schweizerischen Bundesbahnen (1 900 Wörter.)

In English.

Electric Railway Journal. (New York.)

1923 621 .33 (.73) & 656 .211.7 (.73)
Electric Railway Journal, No. 15, April 14, p. 633.
East Bay electric service of the Southern Pacific Railroad. (3 200 words & fig.)

1923 625 .212 & 669 .1
Electric Railway Journal, No. 16, April 21, p. 679.
MERTEN (W. J.). — The salvage of worn steel **car wheels.** (2 900 words & fig.)

1923 656 .253 (.73)
Electric Railway Journal, No. 17, April 28, p. 711.
DODD (J. N.). — **Signaling** on the Frankford elevated. (3 200 words & fig.)

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1923 385 .09.1 (.51)
Engineer, No. 3509, March 30, p. 333.
Chinese Government Railways. (2 500 words & fig.)

1923 624 .8 (.41)
Engineer, No. 3509, March 30, p. 338.
The Inchinnan **bridge** at Renfrew. (2 900 words & fig.)

1923 621 .331 (.73)
Engineer, No. 3511, April 13, p. 383.
The Lakeside **electric power station** at Milwaukee (3 000 words & fig.)

1923 621 .135.2 (.485)
Engineer, No. 3511, April 13, p. 402.
Ball and roller bearings for locomotive and carriage axles. (400 words & fig.)

1923 624. (01
Engineer, No. 3512, April 20, p. 411.
PARR (P. H.). — Equivalent **loads on bridges.** (1 900 words, 1 table & fig.)

1923 621 .116
Engineer, No. 3513, April 27, p. 437.
KERSHAW (J. B. C.). — The **control of boilers** by temperature and draught measurements. (3 800 words & fig.)

1923 62. (01
Engineer, No. 3513, April 27, p. 444.
Institution of mechanical engineers. **Hardness tests.** (3 400 words & fig.)

Engineering. (London.)

1923 669. (01
Engineering, No. 2989, April 13, p. 477.
PORTEVIN (A. M.). — The **structure of eutectics** (5 600 words & fig.)

1923 624 .5 (.42) & 721 .9 (.42)
Engineering, No. 2991, April 27, p. 514.
Reinforced-concrete overbridge at Neepsend, Sheffield. (2 400 words & fig.)

1923 621 .134.2 (.45)
Engineering, No. 2991, April 27, p. 522.
The Caprotti **locomotive valve gear.** (1 400 words & fig.)

1923 62. (01
Engineering, No. 2991, April 27, p. 534.
BATSON (R. G. C.). — **Static indentation tests.** (3 600 words, 7 tables & fig.)

1923 62. (01
Engineering, No. 2991, April 27, p. 537.
HANKINS (G. A.). — The relation between width of scratch and load on diamond in the scratch **hardness test.** (3 300 words, 8 tables & fig.)

1923 621 .134.3 (.42)
Engineering, No. 2993, May 11, p. 596.
The **Walschaert gear** adopted to inside cylinder locomotives. (800 words & fig.)

Engineering News-Record. (New York.)

1923 625 .13 (.73) & 721 .9 (.73)
Engineering News-Record, No. 13, March 29, p. 568.
HIRSCHTHAL. — Flat-slab designs for two railway **elevated stations.** (4 000 words & fig.)

1923 691
Engineering News-Record, No. 13, March 29, p. 596.
Protecting steel bridges from locomotive blast. (700 words & fig.)

1923 625 .13 (.73) & 625 .4 (.73)
Engineering News-Record, No. 14, April 5, p. 617.
THOMPSON (W. E.). — Effects of grouting and gravel packing around **tunnel.** (2 600 words & fig.)

1923 624 .63 (.73)
Engineering News-Record, No. 15, April 12, p. 654.
Building a new **concrete bridge** over an old one. (2 200 words & fig.)

1923 625 .13 (.73) & 691 (.73)
Engineering News-Record, No. 15, April 12, p. 669.
Precast concrete units used for relining **railroad tunnels.** (1 200 words & fig.)

1923 656 .212.4 (.73)
Engineering News-Record, No. 17, April 26, p. 746.
Gravity freight yard at Canton, Ohio; W. & L. E. Ry. (2 300 words & fig.)

1923 625 .142.2 (.73) & 691 (.73)
Engineering News-Record, No. 18, May 3, p. 782.
Timber treating plant operates different processes. (2 800 words & fig.)

1923 624 .61 (.45)
Engineering News-Record, No. 19, May 10, p. 820.
GUTMANN (I.). — Record height **multiple-arch dam** under way in Italy. (3 000 words & fig.)

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1923 621 .39
Engineering Review and Trader, April, p. 301.
WILLIAMS (R. G.). — Modern **welding** practice. (2 900 words & fig.)

Journal of the Institute of transport. (London.)

1923 656 .212.6 (.42)
Journal of the Institute of transport, May, p. 233.
BENTHAM (C.). — **Labour-saving appliances.** (5 700 words & fig.)

Journal of the Western Society of Engineers. (Chicago.)

1923 621 .133.7 & 725 .33
Journal Western Society of Engineers, May, p. 214.
KOYL (C. H.). — Economics of **water service** for railway locomotives. (5 800 words.)

Mechanical Engineering. (New York.)

1923 621 .135.2 & 625 .214
Mechanical Engineering, May, p. 315.
Viscosity of **lubricating oils** at high pressures. (900 words.)

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1923 625 .13
Proceed. Amer. Soc. Civil Eng., April, p. 661.
DUNN (Ch. P.). — Elastic stresses in the rock surrounding pressure **tunnels.** (1 800 words & fig.)

1923 624. (01
Proceed. Amer. Soc. Civil Eng., May, p. 952.
STEINMAN (D. B.). — **Locomotive loadings** for railway bridges. (13 400 words, 2 tables & fig.)

Proceedings Institution of Railway Signal Engineers. (Manchester.)

1923 656 .256.3
Proceed. Institut. Ry. Signal Eng., Session 1922, p. 59.
CARSLAKE (C.). — Intermediate **block signalling.** (9 700 words.)

1923 656 .251
Proceed. Institut. Ry. Signal Eng., Session 1922, p. 85.
PROUD (R. S.). — **Location of signals** as an aid to traffic-working. (7 300 words & fig.)

1923 656 .253 (.493)
Proceed. Institut. Ry. Signal Eng., Session 1922, p. 149.
LASCELLES (T. S.).— Weissenbruch's signal system on the Belgian State Railways. (12 500 words & fig.)

Railway Age. (New York.)

1923 656 .253 (.73)
Railway Age, No. 17, March 31, p. 861.
Test of the **Automatic control** company's device. (1 000 words & fig.)

1923 656 .211.4 (.73)
Railway Age, No. 18, April 7, p. 901.
Portland terminal Company increases facilities. (2 500 words & fig.)

1923 625 .142.2 (.73) & 691 (.73)
Railway Age, No. 18, April 7, p. 911.
Treating ties with creosote in two minutes. (1 000 words & fig.)

1923 625 .232 (.51)
Railway Age, No. 18, April 7, p. 913.
De luxe passenger cars for Chinese Railway. (700 words & fig.)

1923 621 .335 (.73)
Railway Age, No. 19, April 14, p. 945.
WURTS (T. C.). — Electric locomotives for the Norfolk & Western. (1 800 words & fig.)

1923 385. (09.2
Railway Age, No. 19, April 14, p. 955.
Stuyvesant Fish. (400 words & portrait.)

1923 625 .215 (.73)
Railway Age, No. 20, April 21, p. 993.
The Boyden six-wheel co-ordinating truck. (1 000 words & fig.)

1923 624 .1 (.73)
Railway Age, No. 20, April 21, p. 997.
L. & N. designs bridge to resist Gulf Hurricanes. (1 300 words & fig.)

1923 385. (09.3 (.73)
Railway Age, No. 21, April 28, p. 1033.
Early history of the Delaware & Hudson Co. (3 800 words & fig.)

1923 625 .212. (01
Railway Age, No. 21, April 28, p. 1047.
Properties of chilled iron car wheels. (4 300 words & fig.)

1923 621 .133.1 (.73)
Railway Age, No. 21, April 28, p. 1053.
BABCOCK (A. H.). — Fuel consumption of oil burning locomotives. (2 300 words, 2 tables & fig.)

1923 656 .211.4 (.73)
Railway Age, No. 21, April 28, p. 1065.
Another plan for a terminal at Chicago. (1 000 words & fig.)

1923 725 .33 (.73)
Railway Age, No. 22, May 5, p. 1111.
Marked economics affected by water service. (3 800 words & fig.)

1923 621 .33 (.73)
Railway Age, No. 22, May 5, p. 1115.
Virginian to electrify 134 miles of lines. (1 300 words & fig.)

1923 656 .213 (.73)
Railway Age, No. 24, May 19, p. 1195.
New deep water terminal put in operation. (3 200 words & fig.)

1923 621 .132.3 (.73) & 621 .132.5 (.73)
Railway Age, No. 24, May 19, p. 1207.
Mountain and Mikado types for the Frisco. (600 words, 1 table & fig.)

Railway Engineer. (London.)

1923 656 .257 (.42)
Railway Engineer, May, p. 183.
Route-lever signalling, Winchester, Great Western Railway. (2 600 words & fig.)

Railway Engineering & Maintenance. (Chicago.)

1923 725 .33 (.73)
Railway Engineering & Maintenance, May, p. 182.
STEEL (D. A.). — How the Illinois Central handles its water service. (9 400 words & fig.)

1923 625 .13 (.73)
Railway Engineering & Maintenance, May, p. 195.
Special harness supports spans. (900 words & fig.)

Railway Gazette & News. (London.)

1923 621 .132.1 (.439)
Railway Gazette & News, No. 13, March 30, p. 524.
Present-day locomotive practice in Hungary. (1 600 words & fig.)

1923 621 .132.5 (.41)
Railway Gazette & News, No. 14, April 6, p. 555.
New 2-6-0 type engines for the Dublin & South Eastern Railway. (300 words & fig.)

1923 625 .232 (.41)
Railway Gazette & News, No. 14, April 6, p. 556.
New passenger rolling stock, Great Northern Railway (Ireland). (1 400 words & fig.)

1923 621 .336 (.73)
Railway Gazette & News, No. 15, April 13, p. 587.
A modern system of overhead railway track construction. (1 300 words & fig.)

1923 625 .252 (.42)
Railway Gazette & News, No. 15, April 13, p. 592.
New « either side » brake for railway freight stock. (900 words & fig.)

1923 621 .335 (.52)
Railway Gazette & News, No. 16, April 20, p. 615.
New electric main line locomotives for Japan. (1 200 words & fig.)

1923 625 .216 (.73)
Railway Gazette & News, No. 16, 20 April, p. 617.
Automatic couplings. (800 words & fig.)

1923 621 .138.2 (.42) & 656 .212.6 (.42)
Railway Gazette & News, No. 16, 20 April, p. 624.
Mechanical coaling plant at Stratford, London & North Eastern Railway. (1 000 words & fig.)

1923 656 .211.5 (.42)
Railway Gazette & News, No. 17, April 27, p. 645.
The **Glasgow passenger traffic** of the Caledonian Railway. (2 800 words & fig.)

1923 385 .113 (.42)
Railway Gazette & News, No. 17, April 27, p. 651.
British railways in 1922. (2 900 words & 6 tables.)

1923 625 .216 (.42) & 656 .283 (.42)
Railway Gazette & News, No. 18, May 4, p. 688.
Collision at Marylebone demonstrates utility of corrugated fenders and **anti-collision buffers**. (1 500 words & fig.)

1923 621 .33 (09.1 (.3)
Railway Gazette & News, No. 19, May 11, p. 726.
Sir Philip DAWSON. — The financial prospects of **railway electrification**. (3 200 words.)

1923 621 .131.3 (.42) & 621 .132.3 (.42)
Railway Gazette & News, No. 20, May 18, p. 752.
Locomotive tests between Crewe and Carlisle, London, Midland & Scottish Railway. (1 300 words & fig.)

1923 621 .33 (.82)
Railway Gazette & News, No. 20, May 18, p. 756.
Electrification of suburban lines, Buenos Ayres Western Railway. (3 000 words, 1 table & fig.)

1923 625 .232 (.42)
Railway Gazette & News, No. 21, May 25, p. 784.
New main line **express trains**, Great Western Railway. (2 000 words & fig.)

Railway and Locomotive Engineering. (New York.)

1923 621 .335 (.73)
Railway and Locomotive Engin., April, p. 121.
CLARDY (W. J.). — Twelve new **180-ton electric locomotives**. (1 600 words & fig.)

1923 625 .143.3
Railway and Locomotive Engin., April, p. 123.
The **breakage of rails**. (1 000 words & fig.)

1923 625 .253 (.43)
Railway and Locomotive Engin., May, p. 143.
The **Kunze-Knorr air brake**. (2 400 words & fig.)

Railway Magazine. (London.)

1923 656 .222.1 (.42)
Railway Magazine, April, p. 295.
— — May, p. 368.
— — June, p. 465.
ALLEN (C. J.). — **British locomotive practice** and performance. (13 500 words, 6 tables & fig.)

1923 656 .256 (.44)
Railway Magazine, May, p. 379.
PALMER (C. H.). — Some features of **French railway signalling**. (4 500 words & fig.)

Railway Mechanical Engineer. (New York.)

1923 621 .133.5
Railway Mechanical Engineer, April, p. 201.
STUART (T. E.). — **Drafting the locomotive.** (2 500 words & fig.)

1923 625 .235
Railway Mechanical Engineer, April, p. 219.
Treated timber decreases service **cost of cars.** (1 800 words.)

1923 625 .212. (01 & 669 .1
Railway Mechanical Engineer, April, p. 221.
BURGESS (G. K.) & QUICK (G. W.). — **Thermal** stresses in **steel car wheels.** (2 900 words, 4 tables & fig.)

1923 621 .135.2 & 625 .214
Railway Mechanical Engineer, April, p. 225.
BRUNNER (H. E.). — Advantages of the spherical **type roller bearing.** (2 000 words & fig.)

1923 621 .138.1 (.73)
Railway Mechanical Engineer, April, p. 233.
SILCOX (L. K.). — A mechanical man's view on **engine terminal design and operation.** (2 800 words & fig.)

1923 621 .134.1 (.73)
Railway Mechanical Engineer, May, p. 268.
Unique type of **crosshead** for heavy locomotives. (1 000 words & fig.)

1923 621 .132.8
Railway Mechanical Engineer, May, p. 276.
Garratt **articulated locomotives.** (1 000 words & fig.)

Railway Review. (Chicago.)

1923 656 .253. (01
Railway Review, No. 12, March 24, p. 544.
DODGSON (F. L.). — Some fundamentals of **train control.** (7 200 words & fig.)

1923 621 .335 (.73)
Railway Review, No. 13, March 31, p. 569.
CLARDY (W. J.). — **Electric power** for N. Y. N. H. & H. heavy passenger service. (2 200 words & fig.)

1923 621 .133.3
Railway Review, No. 13, March 31, p. 578.
SELEY (C. A.). — Some notes on **boiler circulation.** (3 200 words & fig.)

1923 656 .257 (.73)
Railway Review, No. 13, March 31, p. 580.
BURNS (W. G.). — New **electric interlocking** on the Delaware & Hudson Co. (1 000 words & fig.)

1923 656 .211.4 (.73)
Railway Review, No. 14, April 7, p. 605.
Construction of Union **passenger station** at Indianapolis. (5 400 words & fig.)

1923 621 .335 (.73)
Railway Review, No. 15, April 14, p. 647.
WURTZ (T. C.). — New 4 000 H. P. electric locomotives for N. & W. Ry. (2 300 words & fig.)

1923 656 .255 (.73)
Railway Review, No. 15, April 14, p. 650.
Single track operation by signal indication. (3 000 words & fig.)

1923 625 .142.2 (.73) & 691 (.73)
Railway Review, No. 15, April 14, p. 656.
New tie treating plant of the Oregon Short Line. (800 words & fig.)

1923 621 .134.2 (.73)
Railway Review, No. 16, April 21, p. 677.
Operation of automatic locomotive cut-off control. (7 600 words & fig.)

1923 621 .132.8 (.71)
Railway Review, No. 17, April 28, p. 715.
Rendering a service that the modern public want. (3 000 words & fig.)

1923 656 .213 (.73) & 725 .34 (.73)
Railway Review, No. 17, April 28, p. 726.
New Claremont freight terminal, L. V. R. R. (1 000 words & fig.)

1923 656 .211.4 (.73) & 656 .212 (.73)
Railway Review, No. 18, May 5, p. 753.
New freight and passenger terminal, N. C. & St. L. Ry. (2 200 words & fig.)

1923 621 .132.5 (.43)
Railway Review, No. 18, May 5, p. 757.
A 3-cylinder Mikado, Newest German type. (1 500 words & fig.)

1923 625 .151 (.73)
Railway Review, No. 18, May 5, p. 765.
Turnout slips and crossings, Chicago Union Station. (1 600 words & fig.)

1923 385 .4 (.73)
Railway Review, No. 19, May 12, p. 795.
Control of purchases and stores on the C. & O. Ry. (6 700 words & fig.)

Railway Signal Engineer. (Chicago.)

1923 656 .253 (.73)
Railway Signal Engineer, April, p. 157.
DODGSON (F. L.). — How train control affects operation. (5 100 words & fig.)

1923 656 .253 (.73)
Railway Signal Engineer, May, p. 205.
Signaling of the Frankford Elevated. (5 400 words & fig.)

1923 656 .257 (.42)
Railway Signal Engineer, May, p. 211.
Interesting interlockers on the G. N. (1 500 words & fig.)

University of Illinois Bulletin. (Urbana.)

1923 62. (01 & 625 .212. (01 (.73)
University of Illinois Bulletin, April 16, p. 9.
SNODGRASS (J. M.) & GUIDNER (F. H.). — An investigation of the properties of chilled iron car wheels. (11 800 words, 8 tables & fig.)

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[016 .385. (02]

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[1] The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science," by Weissenbruch, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1509.)

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How the **capacity of a line** can be increased. (2 200 words & fig.)

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Burlington develops large new **freight station.** (2 600 words & fig.)

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Railway development in **Japan.** (2 700 words & fig.)

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The « **never-stop** » **system** of continuous passenger transport. (500 words & fig.)

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SALTER (R. W. A.). — The **Imperial Government Railways of Japan.** (3 300 words & fig.)

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Railway Magazine, October, p. 271.
ALLEN (C. J.). — **British locomotive practice** and performance. (6 800 words, 1 table & fig.)

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GAIRNS (J. F.). — Notable **railway stations** and their traffic. (4 300 words & fig.)

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FORCELLA (P.). — Alcune prove di usura su zoccoli da freno in ghisa. (900 parole, 1 tabella & fig.)

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MONTHLY BIBLIOGRAPHY OF RAILWAYS (1)

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[016 .385. (02]

I. — BOOKS.

In French.

1921-1924 33. (02

COLSON (C.), inspecteur général des ponts et chaussées, vice-président du Conseil d'État de France.

Cours d'économie politique professé à l'Ecole polytechnique et à l'Ecole nationale des ponts et chaussées.— Livre V : Les finances publiques et le budget de la France. Livre VI : Les travaux publics et les transports.

Paris (VI[e]), Gauthier-Villars & C[ie], 55, quai des Grands-Augustins. In-8° (250 × 162). Livre V, 476 p. avec un appendice, 1921. (Prix : 14 francs.) Livre VI, 38 pages, avec un appendice, 1924. (Prix : 14 francs.)

1923 62. (01

FÖPPL (Aug.), professeur à l'Université technique de Munich.

Résistance des matériaux et éléments de la théorie mathématique de l'élasticité. — Traduit de l'allemand par HAHN (E.), ingénieur diplômé de l'Ecole polytechnique de Zurich.

Paris, Gauthier-Villars & C[ie]. 1 vol. in-8° (250×160), 90 pages avec fig. (Prix : 30 francs.)

1923 385. (09.1 (.43)

FREISSLER (Max).

Nouvelle carte des chemins de fer de l'Europe centrale.

Vienne, Stephanplatz 5, 2[e] édition, échelle 1: 1 500 000, format 1.80 × 1.30 m. (Prix : murale en 4 feuilles = couronnes-or; sur toile en 4 feuilles = 11 couronnes-or, port et emballage en sus.)

1923 621 .9 (02

AGES (Général), ancien directeur des Ateliers de Bourges.

Cours de machines-outils. — Livre I : La machine, outil et les mécanismes. Livre II : Etude de détail des différents types de machines.

Paris (V[e]), Librairie de l'enseignement technique, Léon Eyrolles, éditeur, 3, rue Thénard. Livre I, 484 pages 506 fig. (Prix : 30 francs.) Livre II (170×220), 4 pages & 771 fig. (Prix : 40 francs.)

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MAGNY (A.-V.), ingénieur I. D. N.

La construction en béton armé. Théorie et pratique.

Paris (VI[e]), rue des Saints-Pères, 15; Liége, rue des Dominicains, 8, Librairie polytechnique Ch. Béranger. In-16 (155×220), 605 pages & 418 figures. (Prix net : 70 francs).

1923 624 .6 (02 & 721 .4 (02

SÉJOURNÉ (Paul), ingénieur en chef du service de la construction de la Compagnie des chemins de fer de Paris à Lyon et à la Méditerranée, professeur à l'Ecole nationale des ponts et chaussées.

Grandes voûtes.

Bourges (Cher), M[me] V[ve] Tardy-Pigelet et fils, imprimeurs. Six volumes gr. in-4°, 1 362 pages de texte, 236 pages de tableaux synoptiques et 1 847 dessins dans le texte. (Prix : 300 francs.)

1923 621. (02

THIBAUDEAU (J.).

L'ajusteur-mécanicien. 2[e] volume : Travail aux machines.

Paris, L. Eyrolles, 3, rue Thénard. In-8° (180×120), 386 pages, 344 fig.

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1923 721 .9 (02

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Der Beton- und Eisenbetonbau 1898 bis 1923.

Obercassel, Deutscher Beton-Verein (E.V.). 417 Seiten, 284 Abb.

1923 313 .385 (.43)

REICHSVERKEHRSMINISTERIUM.

Die deutschen Eisenbahnen 1910-1920.

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1917, 1921 und 1923 385. (03

RÖLL (Dr. Freiherrn von), früherem Sektionschef im k. k. œsterr. Eisenbahnministerium.

Enzyklopædie des Eisenbahnwesens. Achter, neunter und zehnter Band: Personentunnel bis Zwischenstation.

Berlin-Wien, Urban und Schwarzenberg. Zweite vollständig neubearbeitete Auflage, mit zahlreichen Textabbildungen, Tafeln und Eisenbahnkarten.

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(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science," by WEISSENBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1509.)

1923 621 .131
SCHELEST (A.), Dipl.-Ing.
Probleme der wirtschaftlichen Lokomotiven.
Leipzig und Wien, Franz Deuticke.

In English.

1923 669 .1 (02
DALBY (W. E.).
Strength and structure of steel and other metals.
London, W. 1., Edward Arnold & Co., 41 and 43, Maddox Street. (Price : 18 s. net.)

1923 313 .385 (.59) & 385. (08 (.59)
FEDERATED MALAY STATES RAILWAYS.
Report for the year 1922.
Kuala Lumpur. Printed at the Federated Malay States Government Printing Office. 4°, 43 pages, illustr. with a map.

1923 624 .8 (02
Movable and long- span steel bridges. Compiled by a staff of specialists.
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1923 385. (09.1 (.42) & 385 .4 (.42)
SIMNETT (W. E.), M. B. E., Assoc. Inst. C. E., Railways Amalgamation Tribunal, Late Director, Ministry of Transport.
Railway Amalgamation in Great Britain.
London S. W. 1., 33, Tothill Street, Westminster. Published by « The Railway Gazette ». 270 pages. Cloth, 4 maps. (Price : 15 s. net.)

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Annual report of the South Australian Railways commissioner for the year 1922-1923.
Adelaide, R. E. E. Rogers, Government printer, North Terrace. 4°, xxiv-39 pages, diagr. fig. and a map.

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STUART (Charles W. T.).
Car lighting by electricity.
London, S. W. 1., Simmons-Boardman Publishing Company, 34, Victoria Street. (Price : 18 s. 6 d. net.)

1923 62. (0
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Elasticity and strength of materials used in engineering construction : Section III, Theory of torsion in shafting, and double bending of plates.
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1923 385. (0
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New York, Barr-Erhardt Press. (9 × 6 inches) 203 pages, 111 halftones and line cuts. (Price : $3.)

1923 621 .13 (09.3 (.42)
WARREN (J. G. H.).
A century of locomotive building by Robert Stephenson & Co., 1823-1923.
Newcastle-on-Tyne. Published by Andrew Reid & Co. Ltd., Akenside Hill. (11 1/2×8 1/2×1 1/4 inches) 461 pages. (Price : 28 s. net.)

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II. — PERIODICALS.

In French.

Annales des ponts et chaussées. (Paris.)

1923 721 .4 (.44)
Ann. des ponts & chauss., part. techn., juillet-août, p. 92.
GRELOT. — Note sur le calcul des viaducs. (4 200 mots, 7 tableaux & fig.)

Arts et Métiers. (Paris.)

1923 625 .213
Arts et Métiers, septembre, p. 723.
Ressorts simples et ressorts multiples pour traction, compression et chocs. (2 700 mots, tableaux & fig.)

Bulletin des transports internationaux par chemins de fer. (Berne.)

1923 656 .234 (.43) & 656 .235 (.43)
Bull. des transp. intern. par ch. de fer, octobre, p. 238.
Dr. BORN. — Le système de l'index appliqué en Allemagne à la détermination des taxes de transport et des prix des billets. (1 700 mots.)

Chronique des transports. (Paris.)

1923 385 .581 (.494)
Chronique des transports, n° 20, 25 octobre, p. 38.
La prolongation de la durée du travail dans les chemins de fer. (1 200 mots.)

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Génie civil, n° 2146, 29 septembre, p. 289.
Ponts basculants sur l'Oise, à Chauny, et sur le canal de la Haute-Deule, près de Douai. (1 000 mots & fig.)

1923 **621 .31 (01**
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AUBAILE (R.). — **Abaque pour servir au calcul des lignes électriques.** (2 600 mots & fig.)

1923 **621 .335 (.494)**
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Automotrices monophasées des chemins de fer fédéraux suisses. (1 200 mots & fig.)

1923 **625 .14 (01**
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Etude sur les efforts subis par les voies de chemins de fer. (2 100 mots, 2 tableaux & fig.)

1923 **621 .132.8 (.44)**
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Les chemins de fer et les tramways. (Paris.)

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Les ch. de fer et les tramw., octobre, p. 565.
Le freinage des trains de marchandises. (3 800 mots & fig.)

L'Industrie des tramways, chemins de fer et transports publics automobiles. (Paris.)

1923 **385. (09.1 (.494)**
L'Industrie des tramw. et ch. de fer, septembre, p. 301.
ROCHAT (Ch.). — **Situation économique des chemins de fer suisses de 1913 à 1920.** (9 300 mots, tableaux & fig.)

1923 **621 .39 & 625 .143.2**
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SCHOPFER (J.). — **Quelques essais de soudure électrique des rails.** (1 500 mots & fig.)

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1923 **625 .251**
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1923 **625 .213**
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ALLIX (G.). — **Revue des questions de transport.** (5 200 mots.)

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Glasers Annalen. (Berlin.)

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Zeitschrift des Vereines deutscher Ingenieure. (Berlin.)

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Bulletin, American Railway Engineering Association. (Chicago.)

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Electric Railway Journal. (New York.)

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Engineering News-Record. (New York.)

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Journal, Permanent Way Institution. (London.)

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Mechanical Engineering. (New York.)

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Proceedings, American Society of Civil Engineers. (New York.)

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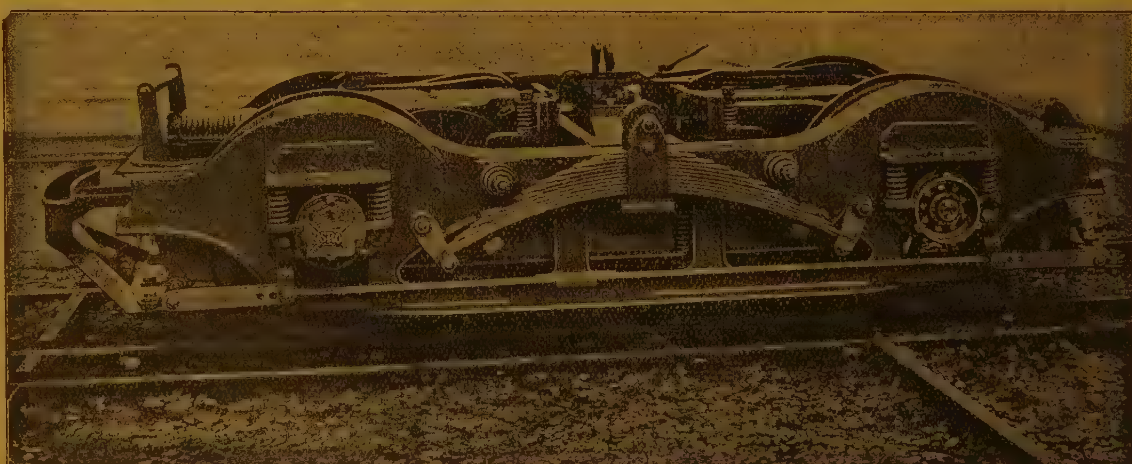

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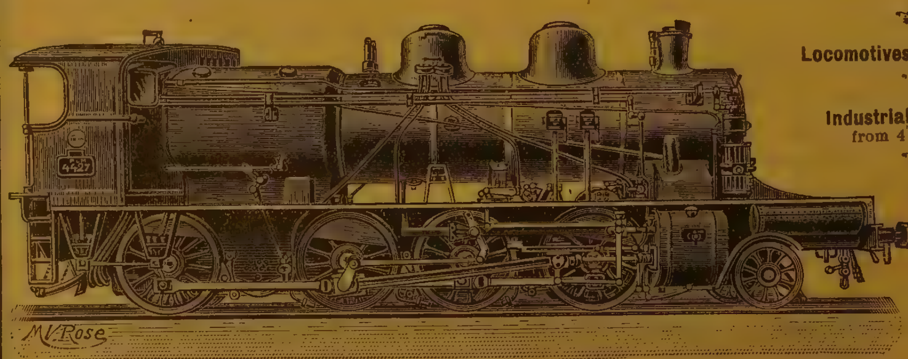

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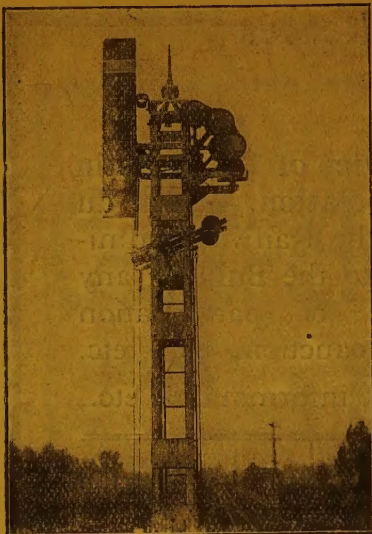

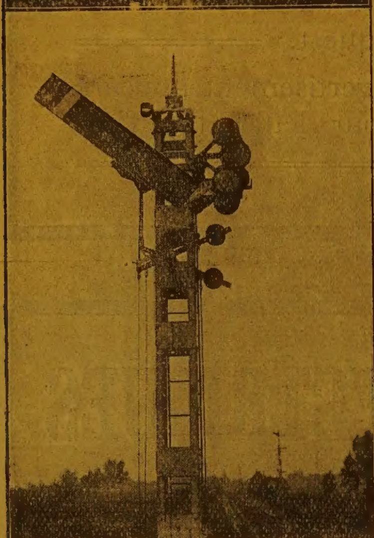

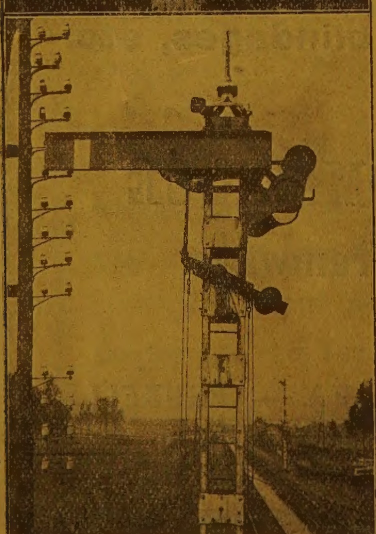

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